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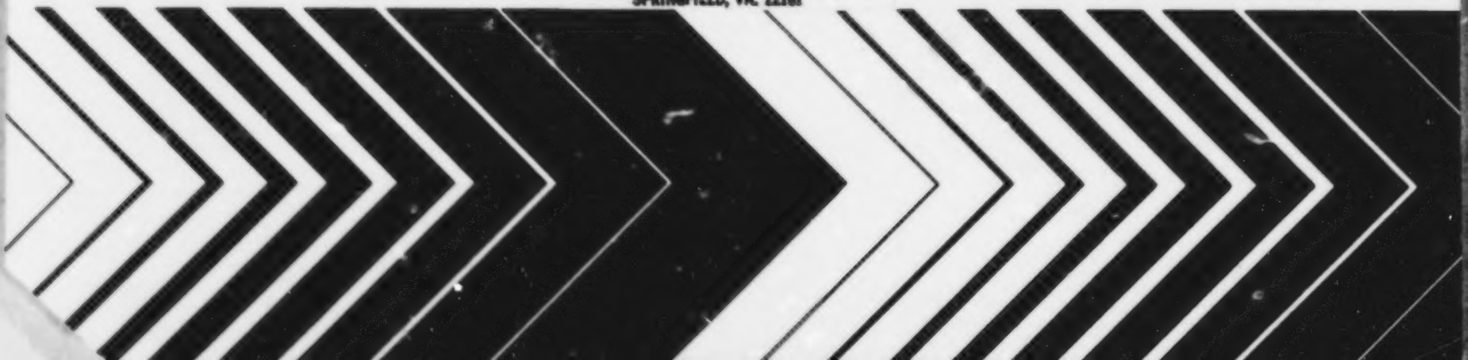

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An epidemiology study which included environmental samples and clinical specimens within a three mile radius of a new sewage treatment plant near Chicago, Illinois was carried out. Evaluations were made before and after plant start-up to determine if operations resulted in any adverse health effect to neighborhood populations. Although aerosols from the aeration basins contained microorganisms, densities of these organisms in neighboring residential area were at background levels. Antibody titers and attempted isolations of pathogenic bacteria, viruses and parasites yielded no evidence of significant public health effects resulting from plant operations.

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HEALTH IMPLICATIONS OF SEWAGE TREATMENT FACILITIES

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This report has been reviewed by the Health Effects Research Laboratory, U.S. Environmental Protection Agency, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the U.S. Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

FOREWORD

The U.S. Environmental Protection Agency was created because of increasing public and government concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimony to the deterioration of our natural environment. The complexity of that environment and the interplay between its components require a concentrated and integrated attack on the problem.

Research and development is that necessary first step in problem solution and it involves defining the problem, measuring its impact, and searching for solutions. The primary mission of the Health Effects Research Laboratory in Cincinnati (HERL) is to provide a sound health effects data base in support of the regulatory activities of the EPA. To this end, HERL conducts a research program to identify, characterize, and quantitate harmful effects of pollutants that may result from exposure to chemical, physical, or biological agents found in the environment. In addition to valuable health information generated by these activities, new research techniques and methods are being developed that contribute to a better understanding of human biochemical and physiological functions, and how these functions are altered by low-level insults.

This report provides an assessment and discussion of the health of persons living near a wastewater treatment plant. With a better understanding of the health effects, measures can be developed to reduce exposure to potentially harmful materials.

RJ Garner

R. J. Garner
Director
Health Effects Research Laboratory

ABSTRACT

It is known that aerosols containing microorganisms and trace metals are emitted from wastewater treatment facilities. Virtually nothing was known about the possible health effects on populations living near these operations. In this study, environmental monitoring, household health survey, and sampling for clinical specimens of human subjects were conducted within a 5 kilometer distance from a wastewater treatment plant near Chicago, Illinois. The residential area began 400 meters from the plant.

Although the treatment plant was a source of indicator bacteria, coliphage, pathogenic bacteria, enteroviruses, and mercury in the aerosols emanating from its aeration basins, the levels of microbiological and chemical agents of the air, water, and soil samples in the neighboring residential areas were not distinguishable from the background levels.

From the patterns observed in the household health survey, the increased incidence of skin disease, and the symptoms of nausea, vomiting, general weakness, diarrhea, and pain in chest on deep breathing may be associated with the nearby operation of the wastewater treatment plant.

Although of little practical health significance, alpha-and gamma-hemolytic streptococcus isolations in throat cultures of nearby residents may be related to plant operations. In contrast, 31 viral antibody tests and attempted isolations of many pathogenic bacteria, parasites, and viruses yielded no evidence of an adverse wastewater treatment plant effect.

Overall, the findings did not detect a health hazard for persons living beyond 400 meters from the well-operated wastewater treatment plant.

This report was submitted in fulfillment of Contract No. 68-02-1746 by Southwest Research Institute under the sponsorship of the U.S. Environmental Protection Agency. This report covers the period July 1974 to October 1976, and work was completed as of October 1977.

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SECTION 1

INTRODUCTION

MOTIVATION AND PURPOSE OF THE STUDY

The United States Environmental Protection Agency (USEPA/EPA), through its construction grants program to the states and municipalities, is funding a multi-billion dollar effort to construct new wastewater treatment facilities throughout the United States. These new facilities are required to meet federal regulations regarding discharge of wastes into rivers, lakes and oceans. The EPA also provides technical assistance to the grant recipient regarding the design and location of these wastewater treatment facilities.

In the past, many wastewater treatment plants have been constructed away from populated areas, thus avoiding problems with offensive odors in residential areas. When operated properly, modern wastewater treatment facilities have fewer odor problems, so there is more acceptance of these facilities in residential areas. From an engineering standpoint, the facility should be located as close as possible to the residential area it is serving. Consequently, urban development has placed large populations in closer proximity to treatment facilities in recent years.

Locating a wastewater treatment plant near residential areas may pose a possible health problem in that sewage treatment processes generate aerosols which may contain human pathogenic microorganisms. A commonly utilized wastewater treatment technique is the activated sludge treatment process, which requires that the incoming wastewater be aerated in biological treatment. During aeration, aerosols are formed at the surface of the wastewater. The wastewater at this stage of treatment contains numerous bacteria and viruses because little treatment other than removal of large solids has occurred.

As plans for this study, Health Implications of Sewage Treatment Facilities, were being formulated in early 1974, the literature relevant to the microbiological aerosol health hazard was based primarily on environmental monitoring field studies of limited scope. Hickey and Reist(1) provide a useful summary of this literature and evaluate its significance. The literature has adequately demonstrated that activated sludge treatment processes are a source of microorganisms(2-7) which are carried at least 50 meters downwind from the aeration basin.(3,4,8) These studies used relatively low volume aerosol samplers, such as the Andersen six-stage impactor, which lacked the sensitivity to distinguish between downwind and background concentrations beyond 50 meters downwind from the source.(3,4,6,7,8)

While direct evidence regarding health effects from the aerosols was scanty, the wastewater aerosols were shown to be a source of pathogenic bacteria such as Klebsiella, Salmonella, Proteus, and Pseudomonas, that might infect nearby residents.(5,6,8,10,11) The presence and survival of tubercle bacilli in liquid sewage were taken to indicate a potential tuberculosis health hazard.(12) Enteric viruses, while not detected in wastewater aerosol, were also considered to pose a public health hazard because of their prevalence in wastewater and postulated survival in aerosols.(11,13) The only reported health survey,(14) concerning pneumonia incidence among wastewater treatment plant employees, found these workers had a higher incidence of influenza (+50%) and colds (+28%) than the control group of drinking water treatment workers.

There was a concern that activated sludge treatment plants might be a source of toxic metals such as cadmium, lead, mercury, copper, and zinc. It was reported(15) that elevated levels of cadmium, copper, and zinc were found in sewage containing industrial effluent. The toxic metals were presumably also present in the aerosols from the aeration basins.

In summary, prior studies indicated that aerosols of microorganisms and trace metals were emitted from wastewater treatment facilities such as trickling filters and the aeration basins of activated sludge processes. These studies indicated that microbiological indicator measurements, such as standard plate count and total coliform, and trace metals were elevated in the air just downwind of the wastewater treatment processes. Very little information was obtained regarding specific types and concentrations of pathogenic microorganisms present in the wastewater or in the air. Virtually nothing was known about the possible health effects on populations living near these operations.

The purpose of the environmental epidemiology study reported herein was to identify possible health effects which might be attributed to the operation of a wastewater treatment plant. The identification program was to involve three independent modes of investigation of a selected new activated sludge treatment plant, both before and after its initial operation:

- Environmental monitoring in the vicinity of the site to ascertain the source and transport distances of indicator and pathogenic microorganisms and of trace metals;

- A health survey of a substantial cross-section of the households located within a 5-kilometer (3-mile) radius of the plant aeration basin to examine the incidence of respiratory and intestinal diseases and symptoms;

- Analysis of clinical specimens from over 200 participants residing within 3.5-kilometers (2-miles) of the plant site for pathogenic bacteria, viruses, and parasites; to determine viral antibody titers; and to measure trace metal concentrations.

Each investigation was to ascertain whether the observed data followed a pattern that implicated the sewage treatment plant as a health hazard.

This study was intended to develop information on the health implications of sewage treatment to assist the EPA in balancing the engineering and health concerns regarding locating wastewater treatment facilities near populated areas, and to provide background information for making judgments on measures to minimize aerosol formation. The EPA recognizes that a concomitant of funding is providing assistance in plant design and siting to achieve cost effective wastewater treatment while minimizing the health risks to nearby residents. Through the epidemiological research program it has initiated, which includes this study, the EPA can develop the necessary design and siting information.

DESIGN OF THE STUDY

This study's design characteristics were developed to identify the health implications of operating sewage treatment facilities by examining a new activated sludge treatment plant. The experimental design considerations included determining the health hazards to be evaluated; constructing a sensitive design structure; choosing a suitable study site; selecting the types of samples to be obtained in the three investigation areas (environmental monitoring, health surveys, and clinical specimens); specifying a suitable matrix of analyses of sample types and sampling periods; and incorporating feasible state-of-the-art advances into the initial experimental design.

Both microbiological and trace metal health hazards were selected for investigation. The microbiological agents of concern were the enteric and respiratory human pathogenic bacteria and viruses and the parasitic worms and protozoa. These agents were sought directly in the environmental samples and clinical specimens;

and indirectly through indicator organisms in the environmental monitoring; through disease and symptom incidence in the health surveys; and through viral serology of the blood specimens. The trace metals examined were cadmium, copper, lead, mercury, and zinc. Their concentrations were measured in the environmental samples and clinical specimens, and their effects were sought through the health survey symptomatology.

The general design structure was to make baseline (pre-operational) period versus operational period comparisons at a new activated sludge plant in each of two seasons on the same participants and sampling areas. The self-paired comparison of the results from the operational period against those from the corresponding baseline period is a very sensitive procedure for detecting changes because it eliminates the substantial inherent variability between human subjects and between locations. The identified operational period changes may be caused by operation of the sewage treatment plant.

Factors of longitudinal origin (changes over time) will be confounded with factors of plant origin in a pre-post design. Supplementary analyses that separate plant and longitudinal factors in the operational period are necessary to implicate the plant as a health hazard. The planned design structure made provision for these supplementary analyses by specifying that measurement be taken over the detectable range of distances and directions from the plant.

It is also important to the general design to select a new sewage treatment site. Sorber, et al.(11) suggested that treatment plant workers and nearby residents of an older plant might not show health effects from exposure to microbiological aerosols, because sporadic inhalation of low concentrations of pathogens may confer a degree of immunity.(16) For an epidemiological investigation of microbiological hazards to have the power to identify any health hazards that are present, newly exposed human subjects might be necessary. With a new sewage treatment site, all the potential participants are newly exposed.

The following stringent site selection criteria were required: new activated sludge treatment plant that would initially process at least 1,000,000 gallons per day of municipal wastewater; no existing sewage treatment facility within at least a five-kilometer radius; a plant completion date consistent with the study schedule; and a sufficient residential population within the five-kilometer radius, so the recruitment for an adequate epidemiology study could be performed.

Though there are many new treatment plants under construction in the United States, most are additions to existing facilities or new facilities being constructed adjacent to older ones. Another difficulty is that when new plants are being constructed in new or expanding residential areas, they are ordinarily located as far from the development as possible. After a diligent search, the John E. Egan Water Reclamation Plant — located in the suburbs northwest of Chicago, Illinois — was selected. It met most of the site criteria, including about 40,000 people living within the five-kilometer radius. However, as the study commenced, only approximately 100 residences existed within a one-mile radius of the plant site, although numerous homes were under construction within this inner circle.

Periods of several weeks duration in each of two seasons, fall and winter, were chosen for conducting the full range of sampling in both the baseline and operational years. An early fall (late September-early October) sampling period was chosen because the temperature in Chicago was still high enough to examine the potential enteric microbiological hazard, and because a return to the normal daily life-style pattern was presumed, since the children had returned to school. A mid-winter (February) sampling period was selected to maximize the potential respiratory microbiological hazard. Each type of sampling in the operational periods was conducted, as nearly as possible, during the same week of the corresponding baseline sampling to minimize the confounding from temporal and temperature-related factors.

The original human subjects selected as participants were not to be replaced if they dropped out of the study. Each participant was to be his own control, so very sensitive self-paired comparisons of the corresponding operational and baseline results could be performed. In the health surveys and for the soil and water environmental samples, the same locations were to be used in each sampling period, again to improve the sensitivity of the comparisons.

Appropriate types of samples were to be taken in the three areas of investigation. The environmental monitoring was to sample the ambient area, surface soil, and surface water in the vicinity of the sewage treatment plant aeration basin, outward to residential distances (0.3 to 5 km) in all four sampling periods. In the operational periods, the mixed liquor being aerated in the aeration basins was also to be sampled. The health surveys were designed to obtain limited personal information on households and detailed background information on volunteer participants. The household health survey was also to obtain disease and symptom incidence on the household members through a door-to-door interview. Half of the households were to reside within 3.5 kilometers in all directions from the plant site, with the other half residing between 3.5 and 5 kilometers in all directions from the plant. Suitable clinical specimens were to be obtained from the participating human subjects for microbiological and trace metal analyses. The clinical specimens selected were blood, feces, hair, throat swabs, sputum, and urine. A current health status survey eliciting the current disease and symptom experience of the participants was also to be provided.

The study design specified the number of samples of each type to be taken in each of the four sampling periods and the analytical procedures to be performed on each sample. The household health survey was to be conducted only in the fall baseline and operational sampling periods, with health information being collected on the members of 1000 randomly selected households in each survey. From 200 to 240 participants were to be selected from the baseline household volunteers residing within the 3.5-kilometer radius, so at least 140 to 160 would remain to provide clinical specimens through all four sampling periods. The participants were to be equally distributed among four desired age groups:

Pre-School	3 months to 4 years
School	6 to 12 years
Young Adult	21 to 45 years
Elderly	60 years or older

The matrices of environmental samples and human subject samples actually collected and the types of analyses actually performed are summarized in Table 1 for all of the sampling periods. The specific microbiological organisms sought and assayed are given in Section 5, Analytical Methods, and Section 6, Results, later in this report. The months during which the samples for each sampling period were actually obtained are:

Period 1	September-October 1974
Period 2	February 1975
Period 3	September 1975
Period 4	February 1976
Period 5	September-October 1976

Improvements were incorporated in the original study design to take advantage of fortuitous circumstances and of fruitful avenues of investigation discovered in the related epidemiological studies. The commencement of the Egan plant's operation was delayed over six months, so the plant was not yet operating in the fall of 1975 when the fall operational sampling was scheduled to be performed. Meanwhile, the large Lexington Green Apartment complex began accepting occupants just 400 meters to 700 meters northwest of the plant aeration basin. Consequently, several design modifications were made.

The full fall operational sampling was postponed for one year. An interim clinical sampling was to be substituted on approximately 50 additional participants recruited from the Lexington Green Apartments; this interim baseline sampling period was called Period 3. The Lexington Green participants were to provide clinical specimens in the fall operational sampling (Period 5) also. To conserve study funds, the analysis of the

TABLE 1. ENVIRONMENTAL AND HUMAN SUBJECT SAMPLING MATRICES

Environmental Sample Matrix

	Aeration Basin Samples				Air Samples				Soil Samples				Water Samples			
Period	1	2	4	5	1	2	4	5	1	2	4	5	1	2	4	5
Number of Samples for Microbiological Analysis			12	12	28	27	32	72	50	50	50	50	10	10	10	10
Bacteria			X	X	X	X	X	X	X	X	X	X	X	X	X	X
Viruses			X	X	X	X	X	X	X	X	X	X	X	X	X	X
Number of Samples for Trace Metal Analysis			7	7	28	28	33	31	50	50	50	50	10	10	10	10
Cadmium			X	X	X	X	X	X	X	X	X	X	X	X	X	X
Copper					X	X			X	X	X	X	X	X		
Lead			X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mercury			X	X		X*	X	X	X	X	X	X	X	X	X	X
Zinc					X	X			X	X	X	X	X	X		

Human Subject Matrix

	Blood Samples					Feces Samples					Hair Samples				
Period	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Number of Specimens Taken	171	170	34	192	216	211	206	45	185	218	229				190
Microbiological Analysis															
Bacteria						X	X	X	X	X					
Parasites						X	X	X	X	X					
Viral Antibodies	X	X	X	X	X										
Viruses						X	X	X	X	X					
Trace Metal Analysis															
Cadmium	X				X	X				X	X				X
Copper	X					X					X				
Lead	X	X			X	X				X	X				X
Mercury	X				X	X				X	X				X
Zinc	X					X					X				
Hematocrits	X	X			X										
Current Health Status Survey															

	Sputum Samples					Throat Swabs					Urine Samples					Health Questionnaires				
Period	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Number of Specimens Taken	158	184	44	196	202	229	222	49	201	226	225				190	230	222	49	200	227
Microbiological Analysis																				
Bacteria	X	X	X	X	X	X	X	X	X	X										
Parasites																				
Viral Antibodies																				
Viruses						X	X	X	X	X										
Trace Metal Analysis																				
Cadmium											X				X					
Copper											X									
Lead											X				X					
Mercury											X				X					
Zinc											X									
Hematocrits																				
Current Health Status Survey																X	X	X	X	X

X Samples taken and analyzed

* Special mercury sampling for Periods 1 and 2 taken during April, 1975.

winter baseline and operational period environmental samples and clinical specimens was deleted, since a single seasonal comparison in the fall was deemed adequate to identify trace metal health hazards.

Our concurrent extensive aerosol and wastewater monitoring study of spray irrigation at Pleasanton, California developed a superior microbiological aerosol sampling and analytical protocol. The aerosol sampling complexities resolved at Pleasanton also implied that the microbiological air sampling design at the Egan plant would be inadequate to accomplish this study's environmental monitoring study objectives. Consequently, the same microbiological aerosol sampling and analysis protocol developed at Pleasanton was utilized in the fall operational sampling in place of the original air sampling and microbiological analysis protocol.

A University of Cincinnati grant study demonstrated that viral serology tests for many virus types yielded useful health effects measures. Therefore, 100 of our participants with sufficient blood sample volumes were selected as three matched groups (1—Lexington Green, 2—close original participants, 3—far original participants) and their fall baseline and operational blood samples were analyzed using 23 additional viral serology tests.

RESEARCH QUESTIONS

The purpose of this study, to identify the health implications of sewage treatment facilities, has been formulated as specific research questions that take into account the study design. The separate research questions which have been identified for the three independent areas of investigation are listed below by the investigation area. The statistical analysis of the data resulting from each type of sample analysis has addressed the relevant research questions to develop findings regarding identification of potential health hazards.

Environmental Monitoring

Determine whether the sewage treatment plant processes are a significant local source (just downwind of the aeration basin) of pathogenic and indicator bacteria and viruses and trace metals in aerosol form.

If the plant is a significant local source, determine whether the levels downwind from the plant are significantly elevated at residential distance.

Household Health Survey

Characterize the surveyed households by means of their personal, socio-economic, and exposure factor distributions. Determine whether there are significant differences between the baseline and operational survey distributions.

For those illnesses, diseases, and symptoms plausibly related to sewage treatment, determine whether the frequency of occurrence in the operational year is significantly different than in the baseline year.

If the incidence is significantly higher, determine whether frequency pattern as a function of distance from the plant implicates the sewage treatment plant as a potential health hazard.

Human Subject Sampling

Characterize the human subjects with respect both to their duration of participation and to their distributions of personal, socio-economic, medical history, and exposure factors.

For each pathogen analyzed, determine from the self- and seasonally-paired data whether occurrence in the operational year is significantly more frequent than in the baseline year.

If the pathogen incidence increases significantly, determine whether the increase relates to exposure to the sewage treatment plant as opposed to other environmental and personal factors.

Determine whether human trace metal concentrations increased subsequent to plant operation.

Determine whether human subject health status declined subsequent to plant operation.

INTERPRETATION OF FINDINGS

The findings from the statistical analyses have been interpreted carefully. This has been an exploratory study of the potential health hazards associated with sewage treatment plant operation. It has been fairly comprehensive in the numbers and types of samples collected and analyses conducted. Because the study has been both exploratory and comprehensive, it is to be expected that many findings will emerge in each area of investigation and that most will be negative regarding sewage treatment health effects. It was also recognized that isolated statistical findings are subject to error, both intentionally through the significance level set for the hypothesis testing, and unintentionally through use of deficient data. Furthermore, while the study design is good, longitudinal and sporadic effects can be confounded with the treatment plant effects in the findings obtained.

Interpretation of the findings has been based on the criteria of consistency and rationality. The findings in each area of investigation have been summarized. An apparent health hazard classification (negative, uncertain, or positive) has been assigned to each finding by consensus of the investigators in the relevant scientific disciplines. All the findings regarding a potential health hazard have been reviewed across all areas of investigation. The potential enteric virus health hazard, for example, has been examined through the findings from the aeration basin, air, soil, and water environmental sampling; from isolations in throat swab and feces specimens and from antibody titers in blood sera; and from intestinal symptomatology in the health surveys.

The consistency in classification and the reasonableness of the findings about a potential health hazard have been considered, along with the likelihood for confounding, to determine whether it should be identified as a sewage treatment health hazard. This process has led to our evaluation of the health implications of sewage treatment facilities.

PARTICIPATING ORGANIZATIONS AND PRINCIPAL PERSONNEL

The research effort documented in this report has been conducted by Southwest Research Institute with significant support and contributions of a number of other organizations. The following is a listing of participating organizations:

—Southwest Research Institute (SwRI), San Antonio and Houston, Texas
—Southwest Foundation for Research and Education (SFRE), San Antonio, Texas
—The University of Texas at San Antonio (UTSA)
—Aqualab, Streamwood, Illinois
—Naval Biosciences Laboratory (NBL), Oakland, California
—Manpower, Incorporated, Chicago, Illinois
—John E. Egan Water Reclamation Plant, Metropolitan Sanitary District of Greater Chicago (MSD), Schaumburg, Illinois
—Hanover Park Treatment (MSD), Hanover Park, Illinois

The study area extends outward from the John E. Egan Water Reclamation Plant to a radius of five kilometers. Details regarding area of responsibility and principal participating personnel for organizations other than the Metropolitan Sanitary District are presented in Table 2.

TABLE 2. PARTICIPATING ORGANIZATIONS AND KEY PERSONNEL

Organization	Responsibility of Organization	Key Personnel	Primary Responsibility of Key Personnel
SwRI	Project direction and final results	D. E. Johnson, Ph.D.	Project Officer
		J. W. Register, Jr.	Direction of field and lab activities
		R. J. Prevost	Questionnaire Design, Participant Recruitment and Household Health Survey
		D. E. Camann	Statistician
		R. E. Thomas	Statistician
		J. M. Taylor	Air, water and soil sampling
		J. M. Hosenfeld	Clinical specimens Air sampling
		J. L. Gulinson	Meteorology
		C. W. Hall, M.D.	Medical Consultant
SFRE	Analysis of clinical specimens, soil and water samples for pathogenic parasites, bacteria and viruses	S. S. Kalter, Ph.D.	Direction of analysis
		C. H. Milstein	Pathogenic bacteria and viruses
		R. E. Kuntz, D.V.M.	Parasites
		J. Moore	Parasites
UTSA	Analysis of coliphage pathogenic bacteria and viruses (wastewater and aerosols, Period 5)	B. P. Sagik, Ph.D. C. A. Sorber, Ph.D.	Direction of analysis
		M. N. Guentzel, Ph.D.	Analytical methods
		B. E. Moore	Virology
	Air Pollution	J. O. Ledbetter, Ph.D.	Air pollution consultant
Aqualab	Indicator microbial parameters	J. K. Hamilton	Lab director
NBL	Consultant organization	M. A. Chatigny	Consultants in aerobiology
Alexian Brothers Medical Center	Consultant organization	J. Clark, M.D.	Consultant in medical matters
Manpower, Inc.	Temporary employment firm used to hire field survey team	T. Rooney	Air sampling
		R. Purdie	Air sampling
		D. Bennett	
		J. Leason	
		T. Suk	
		G. Tasker	

The organization directing the study is Southwest Research Institute and all other organizations listed are acting in support of SwRI in this study. All personnel listed are permanent professional staff at the various institutions, with the exception of those listed for Manpower, Inc., who are temporary employees hired for field surveys. The field survey team exhibited the same high degree of professionalism as the permanent professional staff.

SECTION 2

CONCLUSIONS

The John E. Egan plant appears to be a source of indicator bacteria, coliphage, pathogenic bacteria, enteroviruses, and mercury in the aerosols emanating from its aeration basins. However, the levels of microbiological or chemical agents of the air, soil, and water samples in the neighboring residential areas were not distinguishable from the background levels.

From the patterns observed in the household health survey, the increased incidence of skin disease, and the symptoms of nausea, vomiting, general weakness, diarrhea, and pain in chest on deep breathing may be associated with the nearby operation of the wastewater treatment plant.

Results for alpha- and gamma-hemolytic streptococci isolations in the throat swabs for the subjects from the Lexington Green Apartments provide some evidence that the pattern may relate to exposure to the wastewater treatment plant aerosols. However, these results are of little practical health concern. In contrast, 31 viral antibody tests and attempted isolations of many pathogenic bacteria, parasites, and viruses yielded no evidence of an adverse wastewater treatment plant effect.

The combined baseline—operational and distance experimental design used in this study is very sensitive for identifying potential health hazards and inferring whether or not the wastewater treatment plant may be their source. However, the findings obtained in this study, when considered overall, did not detect a public health hazard for persons living beyond 400 meters from a well-operated wastewater treatment plant.

High volume aerosol samplers (1,000 liters/min. or higher for a minimum of 30 minutes) are needed to monitor levels of bacterial pathogens in air near wastewater treatment facilities. Aerosol samplers which sample at one liter per minute do not provide the required sensitivity for this type of air monitoring.

Monitoring of viruses in ambient air requires much higher sampling rates or times than are needed for bacterial pathogens because of the very low levels present.

SECTION 3

RECOMMENDATIONS

Another more sensitive epidemiological study with persons living very close to a wastewater treatment plant is necessary to investigate the public health hazard which might possibly be associated with the operation of such plants. The study should emphasize microbiological environmental monitoring, health diaries, and viral serology. The majority of participants should be recruited from within 1.5 km of the plant. A baseline and post-operational study of a large new sewage treatment plant is highly desirable.

The influent of the study plant should be screened to ascertain the most likely health hazards before selecting the microbiological and chemical hazards to monitor in any future epidemiology study.

Primarily negative findings were found relative to adverse health effects related to the transport of pathogenic aerosols to exposed populations. These results should not be accepted as conclusive findings. Large amounts of public funds are being spent to improve the treatment of sewage in the United States. It is very important that the EPA collect sufficient data (sanitary engineering, environmental, epidemiological) to ensure that the design and operation of these facilities provide the necessary treatment of sewage and avoid the production of adverse health effects in populations living nearby.

Environmental monitoring of wastewater and aerosols should be performed at several sewage treatment plants located in various geographic areas of the United States. Much information can be obtained from these types of surveys relative to effects that variation of factors such as meteorological conditions, wastewater treatment procedures, and sewage composition have on levels of microbial pathogens in ambient air.

SECTION 4

THE STUDY SITE

SITE SELECTION PROCESS

The design of this epidemiological study required that a sewage treatment plant be selected that had certain characteristics. However, before the characteristics and a plant site could be matched, it was necessary to find out what plants were being built and expected to become operational between June and December of 1975.

The regional offices of the Environmental Protection Agency were contacted to determine if any municipality or wastewater district had a new sewage treatment plant going into operation in the near future. A review of the grant construction list by EPA personnel gave us further leads.

Another major source of information was the offices of the state governments. A phone call was placed to the state capitol information office to determine what state agency would have information about new sewage treatment plants in that state. Various state departments such as Health, Water Quality Board, or Wastewater sections provided enough information to determine if follow-up calls were necessary to local governments where the plant was under construction. Most of the 48 contiguous states were contacted in this manner.

When a sewage treatment plant appeared to be a potential candidate for the study, detailed information about the plant site and the surrounding area was obtained from the local government. In most cases, the city engineer provided this information. Additional information was supplied by the mayor or city manager, or the design engineer of the treatment plant.

Site Requirements

The selection of a plant site was based on a list of requirements supplied by the EPA. The list was broken down into plant, population and meteorological requirements.

Requirements for Plant Selection--

The sewage treatment plant had to be a new plant being built on a new site and could neither be an expansion of an existing plant nor built on the site of an old plant. The design capacity of the plant had to be one million gallons per day (MGD) or larger and use the activated sludge method of treatment. The design of the plant and the constraint of being a new plant eliminated a vast majority of potential sites. However, other constraints also limited the choice of plant. The plant had to serve a residential area with no heavy industry contributing to the waste influent, and there could not be another sewage treatment plant within a six-mile radius.

Requirements for Population Selection--

The other major factor which influenced the selection or rejection of a plant was the population living around the plant site. Within a 5-kilometer (3-mile) radius of the plant, a minimum of 1,000 households had to be present. Ideally, a constant gradient of people was needed throughout the study area. This meant that an equal number of human participants could be selected at any radius of the circle and could be matched with similar socioeconomic characteristics of other human participants anywhere in the study area. Thus, the site selected should include households adjacent to the plant as well as at various distances from the plant in all directions.

Meteorological Data--

Information relative to meteorological conditions near the prospective plant site was also considered. Ideally if wind speed and direction were somewhat constant, then a large population living around the plant could be exposed to the treatment plant.

Site Visit

Local Government--

The study area surrounding the John E. Egan sewage treatment plant is governed by six different municipal governments located in two counties. Each of these municipalities was contacted and briefed on the proposed activities of the survey team. Permits needed and any other constraints were cleared up before the survey team began any activities in the area.

Without the excellent help and cooperation of the local governments, this study would have been difficult to complete. The village officers in Schaumburg, Elk Grove, Hoffman Estates, Roselle, Itasca, and Rolling Meadows provided the survey team with maps and helpful information and assistance. Likewise, the counties of Cook and DuPage provided valuable assistance.

Hospital Contact for Epidemiological Background of Area--

Background information concerning the epidemiology of the study area was obtained from James Clark, M.D., of the Alexian Brothers Hospital. This hospital is located within the study area and serves a wide population both in the study area and in surrounding communities.

THE SELECTED STUDY SITE

The John E. Egan Water Reclamation Plant

The selected study site was the Metropolitan Sanitary District of Greater Chicago's John E. Egan Water Reclamation Plant (Sewage Treatment Plant—STP). The plant was placed in service December 16, 1975, serving a design population of 160,000 people in an area of 49 square miles. A generalized flow diagram is presented in Figure 1.

The wastewater treatment at the STP is primarily normal to low strength domestic-commercial waste (personal communication). The area served has limited light industry. The influent biochemical oxygen demand (BOD) concentration averages approximately 100 to 150 mg/l. The total suspended solids (TSS) concentration is in the same range (100 to 150 mg/l). The waste flow at plant start-up was in the range of 10-15 MGD.

The daily waste flow presently is in the range of 15 to 20 MGD. The monthly average daily flow is approximately 17 MGD. The flow into the plant is somewhat equalized by a wet well and by allowing the collection system (sewer lines) to act as holding devices. This is done in an attempt to distribute the daily flow variations in a more uniform fashion. The design dry weather daily average flow is 30 MGD. At the present, the plant is hydraulically underloaded.(17)

The treatment plant can be operated in three different modes: as a conventional activated sludge plant; as a step aeration and step loading plant; or as a contact stabilization plant. The plant is presently operated in the conventional mode; that is, the raw sewage is discharged into the head end of a series of long tanks and

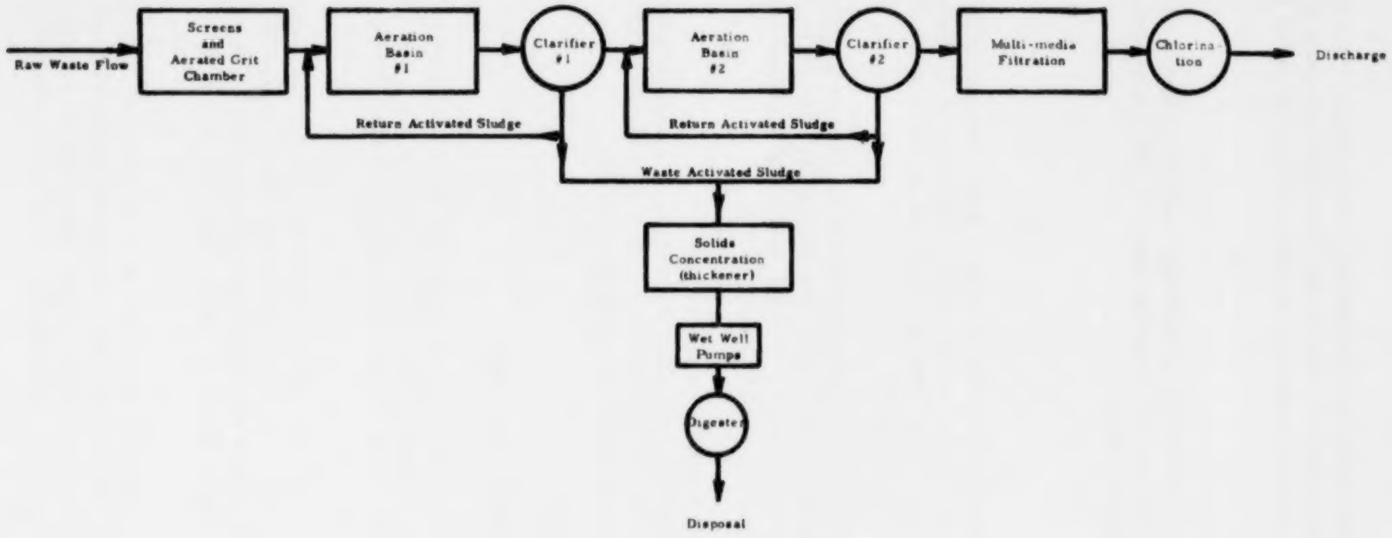

Raw Waste Flow
Screens and Aerated Grit Chamber
Aeration Basin #1
Clarifier #1
Aeration Basin #2
Clarifier #2
Multi-media Filtration
Chlorination
Discharge
Return Activated Sludge
Return Activated Sludge
Waste Activated Sludge
Solids Concentration (thickener)
Wet Well Pumps
Digester
Disposal

Figure 1. John E. Egan Water Reclamation Plant Flow Diagram.

aerated. The plant is a two-stage system as shown in Figure 1. The wastewater enters the first stage aeration basin, is aerated, and then enters the first stage clarifiers where the solids are allowed to settle. Some portion of the solids is returned to the aeration basin with the remainder discharged to the solids concentration tank. The BOD and suspended solids concentration are each approximately 10 mg/l. Very little removal is experienced at the present time in the second stage reactor.

The effluent from the second stage clarifier is discharged to the multi-media filter consisting of coal and sand. The effluent from the filter is chlorinated and discharged to the receiving water. The BOD and suspended solids concentration at discharge are each approximately 3 mg/l. The effluent limits for the plant are:

BOD—4 mg/l
TSS—5 mg/l
NH_3—summer, 2 mg/l
winter, 4 mg/l

The plant appears to be successfully meeting the effluent requirements at the present time.

The production of aerosols was the primary health concern investigated in this study. The first and second stage aeration basins produce the greatest amount of aerosols as these are aerated by blowing diffused air into the tanks. The grit chamber is aerated and the solids concentration tanks (thickener) have the capacity to be aerated, but both potential sources are in enclosed buildings.

The John E. Egan plant is presently operating below its maximum design capacity from both a hydraulic and organic loading standpoint, and is producing a high quality effluent.

The Study Area

Site Description—

A map of the study site is provided in Figure 2. The John E. Egan Sewage Treatment Plant is located at the center of the map, on Salt Creek, a tributary of the Des Plaines River. The area is located in the northwest portion of the Chicago Metropolitan area, approximately 35 miles from the downtown business district. A number of suburban communities, incorporated as villages, surround the John E. Egan Plant. These are the villages of Rolling Meadows, Arlington Heights, Elk Grove Village, Itasca, Schaumburg, and Hoffman Estates.

The study site was divided into an inner and outer region, by concentric circles as shown in Figure 2, at 3.5 km and 5 km from the sewage treatment plant. Thus, the inner region lies within a circle of 3.5-km radius, and the outer region is a bank from 3.5 to 5 km from the plant. Persons residing within the inner region served the study as the population-at-risk and persons within the outer region served as a control group. For the purpose of surveying, each of these regions is divided into sectors as depicted. The original design was to have approximately equal population in each of twenty sectors, ten in each of the two regions. Each sector was to define a specific direction and distance from the plant. Actually, the twenty-one sectors shown were developed with use of maps and census data for the area.

To accomplish the study goal of 1,000 house-to-house surveys, fifty surveys would need to be accomplished in each of the original twenty sectors. Because participants were to be recruited from the surveys within the inner sectors, eleven sectors were selected rather than ten. This would provide 550 household surveys if 50 were accomplished within each sector, and would provide an adequate base for selection of the 250 participants for which the study was designed.

It will be noticed that the sectors have somewhat irregular boundaries. This was a result of "gerrymandering" the originally regular boundaries so a sufficient population was to be found in each sector. The

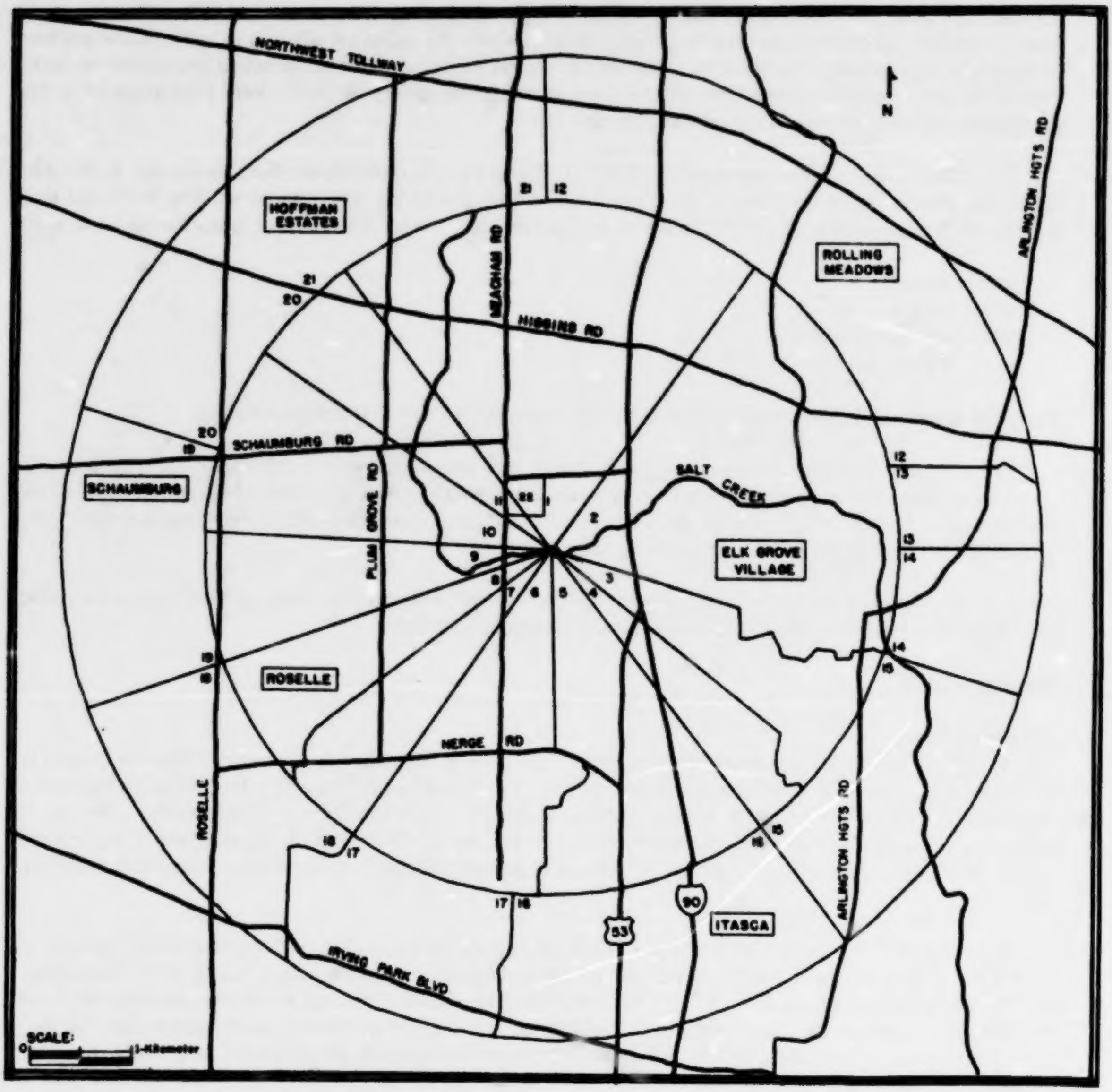

NORTHWEST TOLLWAY
N
ARLINGTON HGTS RD
21
12
HOFFMAN ESTATES
MEACHAM RD
ROLLING MEADOWS
21
20
HIGGINS RD
20
19
SCHAUMBURG RD
12
13
SALT CREEK
SCHAUMBURG
PLUM GROVE RD
11
22
1
2
10
9
ELK GROVE VILLAGE
13
14
3
8
7
6
5
4
14
15
19
18
ROSELLE
NERGE RD
ROSELLE
18
17
16
15
ARLINGTON HGTS RD
17
16
90
53
ITASCA
IRVING PARK BLVD
SCALE:
0
1-Kilometer

Figure 2. John E. Egan STP project study area map.

boundaries follow natural boundaries between neighborhoods where appropriate. After the initial design of twenty-one sectors, a twenty-second sector was designated for a new community, Lexington Green, which was developed very near the sewage treatment plant during the early stages of this study. Section 22 incorporates the portions of Sectors 1 and 11 within 1/2 km of the plant.

Characteristics of the Area

The study area is located approximately 25 miles northwest of downtown Chicago, Illinois. The area occupies a plain, which for the most part, is only some tens of feet above Lake Michigan (579 feet above mean sea level). Topography does not significantly alter air flow, except that lesser frictional drag over Lake Michigan causes winds to frequently be stronger along the lakeshore.

The study area is in a region of frequently changeable weather. The climate is predominately continental, ranging from relatively warm in summer to relatively cold in winter. However, the continentality is partially modified by Lake Michigan and to a lesser extent by the other Great Lakes. Temperatures of 96°F or higher occur in about half the summers, while about half the winters have a minimum as low as -15°F.

Precipitation falls mostly from air that has passed over the Gulf of Mexico with some influence from Lake Michigan especially during the winter. About one-half the precipitation in winter and about 10 percent of the yearly total precipitation falls as snow. Snowfall from month to month and year to year is greatly variable. Freezing rain sometimes occurs but is usually light. Precipitation during the summer occurs as thunderstorms which are often locally heavy and variable. Longer periods of continuous precipitation occur mostly in autumn, winter, and spring.

The amount of sunshine is moderate in summer and quite low in winter. A considerable amount of cloudiness, especially in winter, is locally produced by lake effect. Days in summer with no sunshine are rare. The total sunshine in December, partly because of shorter days, is only a little over one-third the July total.

The quadrant from the east to about due north of the Egan treatment plant is a designated forest preserve. Two four-lane highways (Higgins and Arlington Heights Roads) pass through portions of this preserve. Estimated traffic patterns for each of these roads would be between 20,000 and 30,000 cars/day.

The remaining three quadrants of the study area can be described as a mixture of residential, agricultural, and small business tracts. Residential areas are estimated to comprise about 30-40 percent of these quadrants. However, rapid growth in the area is taking over the available farmland and would appear to substantially increase the residential percentage within the next few years. At present, however, the agriculture usage is predominately for grain crops such as corn, wheat, and oats. An estimated 10 percent of the study area is presently commercial enterprise such as shopping malls and business zones along the major thoroughfares.

Potential sources of metals or pathogens within the study area are not limited to any one section of the area. Vehicular traffic would be the major contributor of metals to the environment. Interstate Highway 90 bisects the study area and the Northwest Tollway cuts across the northern section. These two multi-lane, limited-access highways are two of the major roadways from the northwest suburbs to downtown Chicago and as such are heavily traveled. Similar contributions that affect air quality from other multi- and single-lane highways serving the needs of the 50,000 to 75,000 inhabitants of the study area would be expected. Also, within the study area is a vast multi-level shopping mall complex with its many acres of parking that would contribute to the air metal level. Flight paths to O'Hare International Airport cross the northeast, central, and extreme southern portions of the study circle. The O'Hare Airport routinely has over 1,900 take-offs and landings in each 24-hour period. Depending on the wind direction, flight paths over the study area would change and the trace metals emitted from aircraft would affect the study area.

Pathogens might come from various sources both within and adjacent to the study area. Local farmers use a combination of chemical and biological fertilizers for their grain crops. As manure is spread by machine over the fields some form of particulate matter would be emitted to the atmosphere. No feedlots were observed within the study area. Adjacent to the study area are three sewage treatment plants approximately seven to eight miles distance from the Egan plant. To the west and southwest two plants are located with treatment capacities of four and one and one-half MGD, respectively. The other nearby plant is about seven miles to the east in Des Plaines.

Characteristics of the Residents--

The information contained in the Chicago Standard Metropolitan Statistical Area (SMSA) book, based on 1970 U.S. Census, was used to describe the residents of the area according to personal and socio-economic characteristics. Those tracts which fell partially or completely within the 5-km radius around the site are combined and summarized below.

The total population in the exposed tracts was 99,661, of which 49,985, or 50.2 percent were male and 49,676, or 49.8 percent female. The population was racially predominantly white (99.3 percent). From the census data, a breakdown of the population in the area by age and sex categories is made which roughly corresponds to the breakdowns used in this report. The age groupings are: below 5, 5-19, 20-44, and 45 and over. The numbers and percentages for each sex separately and for the total population of the surrounding area are presented in Table 3.

The education level of the people in the area was fairly high. The median number of years completed was approximately 12.5, which means that over half of the adult residents had taken some college work. Of the total population, 7,140 or 7.2 percent, had completed at least 4 years of college work. The total persons employed among these residents was 37,129, and of these, 11,625 or 31.3 percent, were classified as professional or managerial personnel.

The median income for the area based upon the 1970 census was approximately 6,000 dollars, and the mean income was 6,300 dollars.

In the interim between the 1970 census and the survey periods of this study, certain changes occurred within the area. The population of the area began to increase and a substantial rise was observed in home construction. This consisted primarily of single family dwellings, but also included both townhouses and high-rise apartments. The residents tended to be middle class with salaries in the range from $10- to $50,000 per year, and a mixture of professional and blue-collar workers. The area is expected to continue this growth in the coming years.

TABLE 3. AGE-SEX BREAKDOWN OF POPULATION SURROUNDING JOHN EGAN PLANT (1970 Census)

	Category					
	Male		Female		Total	
Age Group	No.	%	No.	%	No.	%
Less than 5	6,938	13.9	6,300	12.7	13,238	13.3
5 - 19	17,971	36.1	17,294	34.8	35,265	35.5
20 - 44	18,579	37.3	19,935	40.1	38,514	38.7
45 and over	6,298	12.7	6,137	12.4	12,435	12.5

SECTION 5

METHODS

HOUSEHOLD SURVEY AND PARTICIPANT RECRUITMENT

General Design

In this study, house-to-house surveys were used to obtain health information on households and to recruit paid participants for more in-depth study. Surveys were accomplished before the initial operation of the John Egan plant and again after operations were underway for a significant period of time. The general design was to accomplish 1,000 house-to-house surveys before the initial operation of the plant, and to recruit 250 participants for an in-depth study to accomplish another 1,000 house-to-house surveys after plant operations were underway. Study participants were recruited during the initial house-to-house survey and these participants remained throughout the study. The second house-to-house survey, accomplished after plant operations, required no recruitment of participants.

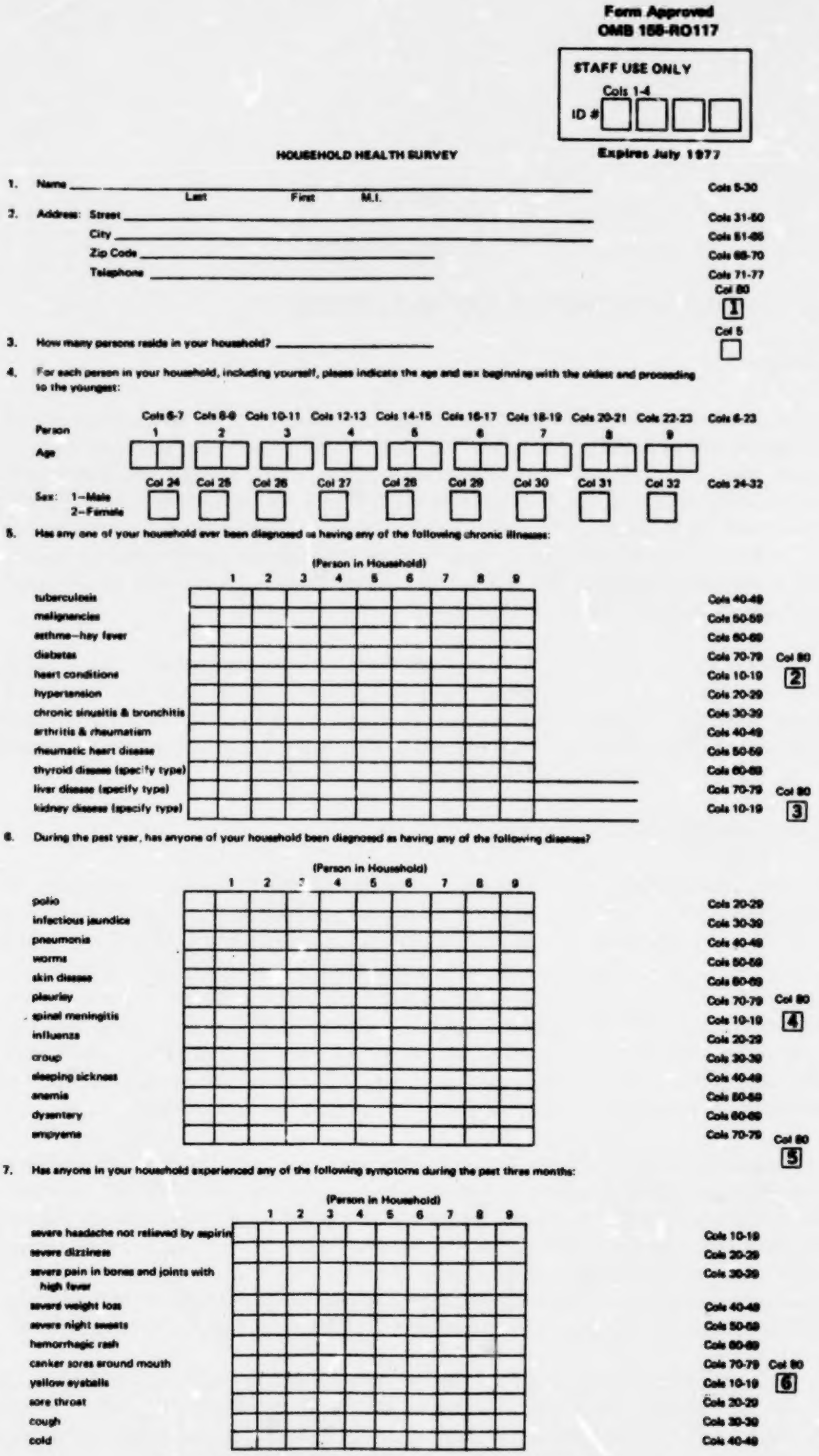
Participants were recruited from the inner region of the study site (Sectors 1-11 in Figure 2 in Section 4). An equal number of participants was desired from four separate age groups: 0-6, 7-18, 19-45, and 46+ years of age. The only restrictions placed on participation were residence in the area for six months or more, an intent to live in the area for at least two years following the initial contact, and no employment at the John Egan plant.

Questionnaire Development

Three questionnaire forms were developed to serve the specific needs of the study. The first form was used to directly obtain household health information for comparison of the general public health before and after the start-up of plant operations and also to compare health of households living near the plant to those living further away. Also, in this first form, a question was included which asked if a person would participate as a paid volunteer in a health study. Thus, the form served as a recruitment device as well as a data collection method. A second form was developed to collect pertinent background information on individuals who indicated a willingness to participate in the study. A third form was developed to obtain more detailed health status information on each participant at frequent intervals during the multi-year study period. Biological samples were also obtained from each of the study participants recruited with the forms.

In the design of the questionnaire forms, project staff with experience in previous public health studies involving recruitment and participation of individuals from the general public were assigned the task of producing a preliminary design for each form. Inputs were obtained from Institute medical staff regarding health and symptomatic information required for the forms. A preliminary design was accomplished and was reviewed with staff of the sponsor organization. Revised versions of each of the three forms were then prepared and submitted with appropriate backup materials to the Office of Management and Budget for official OMB approval. These materials as submitted to OMB, are presented in Appendix A.

The questionnaire forms approved for use in this study are presented in Figures 3, 4, and 5. The Household Health Survey Questionnaire, shown in Figure 3, served to gather information regarding household health and to ask if a person wished to serve the study as a paid participant (Question 15). The



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OMB 158-RO117

STAFF USE ONLY
Cols 1-4
ID # ☐☐☐☐

Expires July 1977

HOUSEHOLD HEALTH SURVEY

1. Name ______________________________ Cols 5-30
Last First M.I.

2. Address: Street ______________________________ Cols 31-50
City ______________________________ Cols 51-65
Zip Code ______________________ Cols 66-70
Telephone ______________________ Cols 71-77
Col 80 [1]

3. How many persons reside in your household? ______________ Col 5 ☐

4. For each person in your household, including yourself, please indicate the age and sex beginning with the oldest and proceeding to the youngest:

	Cols 6-7	Cols 8-9	Cols 10-11	Cols 12-13	Cols 14-15	Cols 16-17	Cols 18-19	Cols 20-21	Cols 22-23	Cols 6-23
Person	1	2	3	4	5	6	7	8	9	
Age	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐	
	Col 24	Col 25	Col 26	Col 27	Col 28	Col 29	Col 30	Col 31	Col 32	Cols 24-32
Sex: 1–Male 2–Female	☐	☐	☐	☐	☐	☐	☐	☐	☐	

5. Has any one of your household ever been diagnosed as having any of the following chronic illnesses:

(Person in Household)

	1	2	3	4	5	6	7	8	9		
tuberculosis										Cols 40-49	
malignancies										Cols 50-59	
asthma–hay fever										Cols 60-69	
diabetes										Cols 70-79	Col 80
heart conditions										Cols 10-19	[2]
hypertension										Cols 20-29	
chronic sinusitis & bronchitis										Cols 30-39	
arthritis & rheumatism										Cols 40-49	
rheumatic heart disease										Cols 50-59	
thyroid disease (specify type)										Cols 60-69	
liver disease (specify type)										Cols 70-79	Col 80
kidney disease (specify type)										Cols 10-19	[3]

6. During the past year, has anyone of your household been diagnosed as having any of the following diseases?

(Person in Household)

	1	2	3	4	5	6	7	8	9		
polio										Cols 20-29	
infectious jaundice										Cols 30-39	
pneumonia										Cols 40-49	
worms										Cols 50-59	
skin disease										Cols 60-69	
pleurisy										Cols 70-79	Col 80
spinal meningitis										Cols 10-19	[4]
influenza										Cols 20-29	
croup										Cols 30-39	
sleeping sickness										Cols 40-49	
anemia										Cols 50-59	
dysentery										Cols 60-69	
empyema										Cols 70-79	Col 80 [5]

7. Has anyone in your household experienced any of the following symptoms during the past three months:

(Person in Household)

	1	2	3	4	5	6	7	8	9		
severe headache not relieved by aspirin										Cols 10-19	
severe dizziness										Cols 20-29	
severe pain in bones and joints with high fever										Cols 30-39	
severe weight loss										Cols 40-49	
severe night sweats										Cols 50-59	
hemorrhagic rash										Cols 60-69	
canker sores around mouth										Cols 70-79	Col 80
yellow eyeballs										Cols 10-19	[6]
sore throat										Cols 20-29	
cough										Cols 30-39	
cold										Cols 40-49	

Figure 3. Household health survey questionnaire.

(continued)

(Person in Household)

	1	2	3	4	5	6	7	8	9		
skin rash face	☐	☐	☐	☐	☐	☐	☐	☐	☐	Cols 50-59	
arms & legs	☐	☐	☐	☐	☐	☐	☐	☐	☐	Cols 60-69	Col 80
body	☐	☐	☐	☐	☐	☐	☐	☐	☐	Cols 70-79	$\boxed{7}$
diarrhea	☐	☐	☐	☐	☐	☐	☐	☐	☐	Cols 10-19	
bloody diarrhea	☐	☐	☐	☐	☐	☐	☐	☐	☐	Cols 20-29	
bloody urine	☐	☐	☐	☐	☐	☐	☐	☐	☐	Cols 30-39	
burning on urination	☐	☐	☐	☐	☐	☐	☐	☐	☐	Cols 40-49	
nausea	☐	☐	☐	☐	☐	☐	☐	☐	☐	Cols 50-59	
vomiting	☐	☐	☐	☐	☐	☐	☐	☐	☐	Cols 60-69	Col 80
pain in chest on deep breathing	☐	☐	☐	☐	☐	☐	☐	☐	☐	Cols 70-79	$\boxed{8}$
weakness of arms or legs	☐	☐	☐	☐	☐	☐	☐	☐	☐	Cols 10-19	
cough up blood	☐	☐	☐	☐	☐	☐	☐	☐	☐	Cols 20-29	
stiff neck with fever	☐	☐	☐	☐	☐	☐	☐	☐	☐	Cols 30-39	
stiff neck with rash	☐	☐	☐	☐	☐	☐	☐	☐	☐	Cols 40-49	
general weakness	☐	☐	☐	☐	☐	☐	☐	☐	☐	Cols 50-59	
draining ear	☐	☐	☐	☐	☐	☐	☐	☐	☐	Cols 60-69	Col 80
fever above 103°F	☐	☐	☐	☐	☐	☐	☐	☐	☐	Cols 70-79	$\boxed{9}$
severe trouble with teeth	☐	☐	☐	☐	☐	☐	☐	☐	☐	Cols 10-19	
colicky pains in abdomen	☐	☐	☐	☐	☐	☐	☐	☐	☐	Cols 20-29	
brown urine	☐	☐	☐	☐	☐	☐	☐	☐	☐	Cols 30-39	
shortness of breath	☐	☐	☐	☐	☐	☐	☐	☐	☐	Cols 40-49	
convulsions	☐	☐	☐	☐	☐	☐	☐	☐	☐	Cols 50-59	
unconsciousness (not due to blow on head)	☐	☐	☐	☐	☐	☐	☐	☐	☐	Cols 60-69	
yellow skin	☐	☐	☐	☐	☐	☐	☐	☐	☐	Cols 70-79	Col 80 $\boxed{+}$

8. How long have you

	Months 0-2	3-5	6-8	9-11	12-23	24-35	more than 3 years	No Response	
Lived in your present city or town?	1	2	3	4	5	6	7	9	Col 6 ☐
Lived at your present address?	1	2	3	4	5	6	7	9	Col 8 ☐

9. How many times have you and your family changed living quarters during the last five years? times — Col 9-10 ☐☐

10. Is your home air conditioned? — Col 12 ☐
1 - No
2 - Yes, window only
3 - Yes, central

11. How many bedrooms do you have in your home? bedrooms — Col 13 ☐

12. What is the usual occupation of the head of your household? — Cols 14-15 ☐☐

Occupation	Code	Occupation	Code	Occupation	Code
Professional	01	Foreman/Craftsman	06	Teacher	11
Administrative	02	Laborer (kitchen, custodial, maintenance)	07	Librarian	12
Technical	03	Student	08	Housewife	13
Clerical (sec'y, file clerk, cashier)	04	Volunteer Worker	09	Public assistance (policeman, fireman)	14
Sales	05	Waiter, waitress	10	Retired	15

13. What educational level has been completed by the head of your household — Col 16 ☐
1 - less than 8th grade
2 - 8th grade
3 - high school - incomplete
4 - high school - completed
5 - college - incomplete
6 - college - completed
7 - graduate school

14. Distance from John Egan Treatment Plant (refer to map for coding A-K) — Col 20 ☐

15. Sector — Cols 22-23 ☐☐

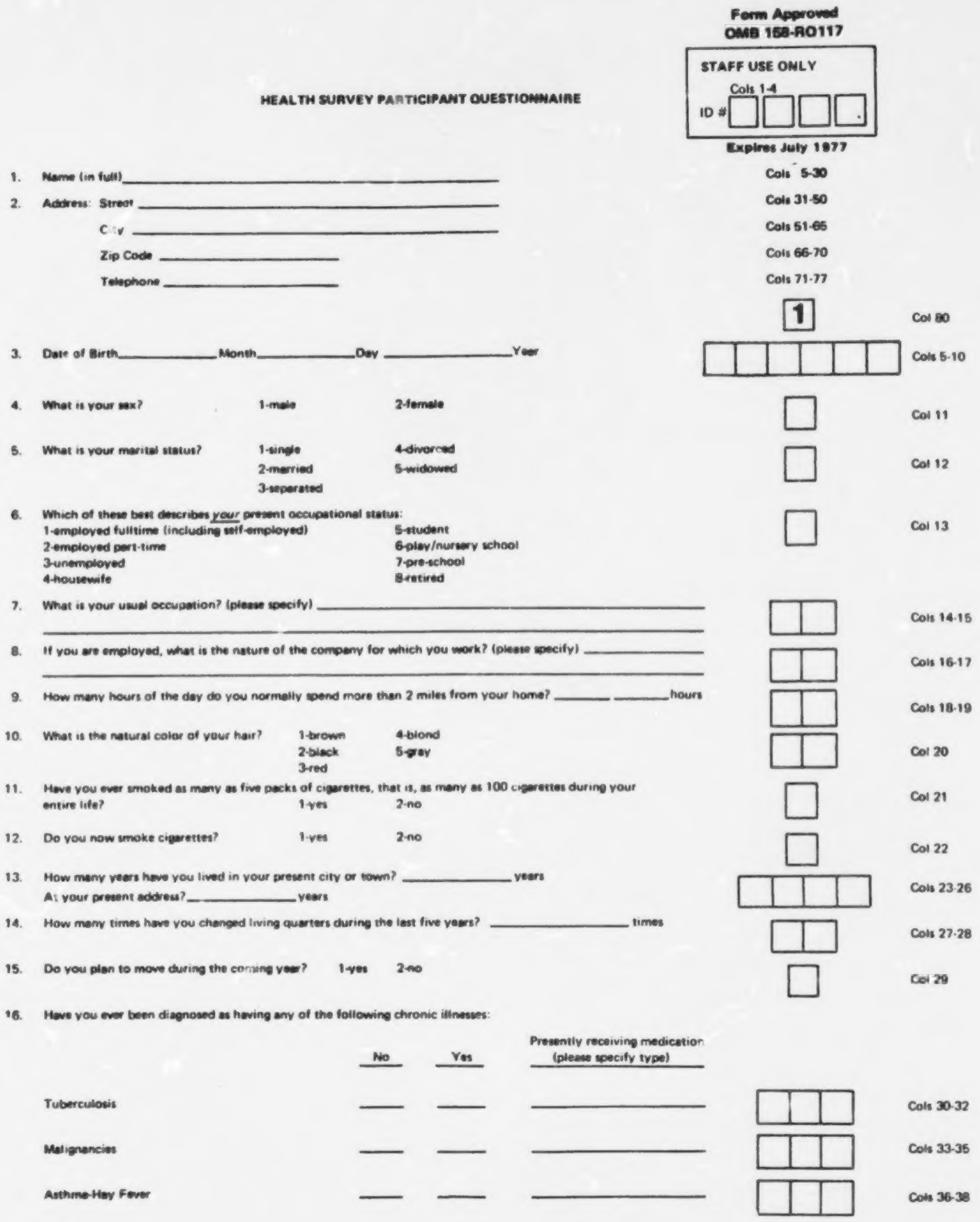
16. Distance to nearest — Cols 24-26 ☐☐

	less than 2 blocks	less than 1 mile	one mile or more
a. freeway, expressway or turnpike	1	2	3
b. other major multilane traffic artery	1	2	3
c. large industrial operation	1	2	3

17. IMNOWO 1 2 3 4 5 6 — Col 27 ☐

Col 80 $\boxed{-}$

Figure 3. (continued)



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Cols 1-4
ID # ☐☐☐☐

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HEALTH SURVEY PARTICIPANT QUESTIONNAIRE

1. Name (in full) ______________________ Cols 5-30

2. Address: Street ______________________ Cols 31-50

City ______________________ Cols 51-65

Zip Code ____________ Cols 66-70

Telephone ____________ Cols 71-77

1 Col 80

3. Date of Birth ________ Month ________ Day ________ Year ☐☐☐☐☐☐ Cols 5-10

4. What is your sex? 1-male 2-female ☐ Col 11

5. What is your marital status? 1-single 2-married 3-seperated 4-divorced 5-widowed ☐ Col 12

6. Which of these best describes *your* present occupational status: ☐ Col 13
1-employed fulltime (including self-employed)
2-employed part-time
3-unemployed
4-housewife
5-student
6-play/nursery school
7-pre-school
8-retired

7. What is your usual occupation? (please specify) ______________________ ☐☐ Cols 14-15

8. If you are employed, what is the nature of the company for which you work? (please specify) ______________________ ☐☐ Cols 16-17

9. How many hours of the day do you normally spend more than 2 miles from your home? ____ ____ hours ☐☐ Cols 18-19

10. What is the natural color of your hair? 1-brown 2-black 3-red 4-blond 5-gray ☐☐ Col 20

11. Have you ever smoked as many as five packs of cigarettes, that is, as many as 100 cigarettes during your entire life? 1-yes 2-no ☐ Col 21

12. Do you now smoke cigarettes? 1-yes 2-no ☐ Col 22

13. How many years have you lived in your present city or town? ________ years
At your present address? ________ years ☐☐☐☐ Cols 23-26

14. How many times have you changed living quarters during the last five years? ________ times ☐☐ Cols 27-28

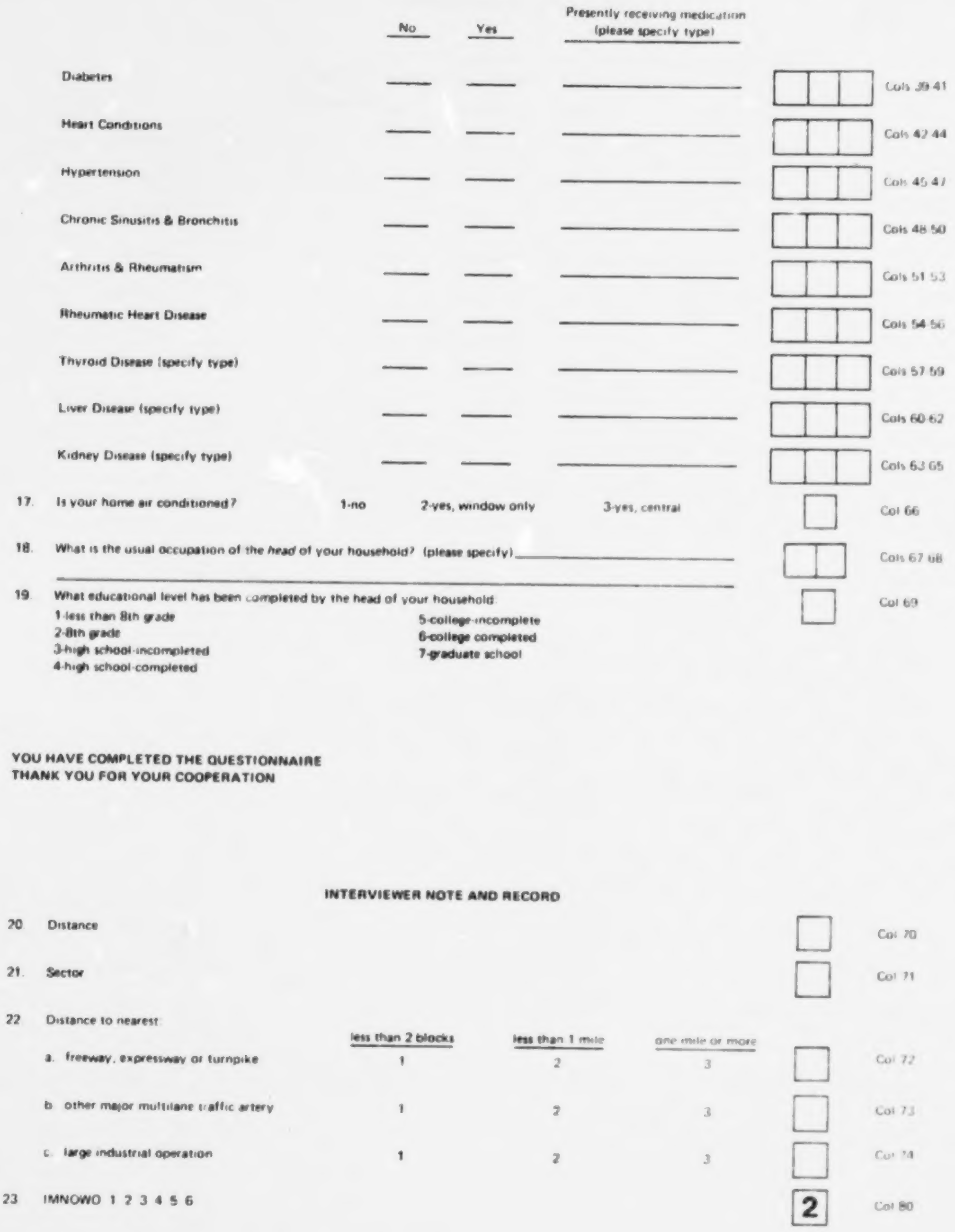
15. Do you plan to move during the coming year? 1-yes 2-no ☐ Col 29

16. Have you ever been diagnosed as having any of the following chronic illnesses:

	No	Yes	Presently receiving medication (please specify type)		
Tuberculosis	____	____	____________	☐☐☐	Cols 30-32
Malignancies	____	____	____________	☐☐☐	Cols 33-35
Asthma-Hay Fever	____	____	____________	☐☐☐	Cols 36-38

Figure 4. Health survey participant questionnaire.

(continued)



	No	Yes	Presently receiving medication (please specify type)		
Diabetes	____	____	____________	☐☐☐	Cols 39 41
Heart Conditions	____	____	____________	☐☐☐	Cols 42 44
Hypertension	____	____	____________	☐☐☐	Cols 45 47
Chronic Sinusitis & Bronchitis	____	____	____________	☐☐☐	Cols 48 50
Arthritis & Rheumatism	____	____	____________	☐☐☐	Cols 51 53
Rheumatic Heart Disease	____	____	____________	☐☐☐	Cols 54 56
Thyroid Disease (specify type)	____	____	____________	☐☐☐	Cols 57 59
Liver Disease (specify type)	____	____	____________	☐☐☐	Cols 60 62
Kidney Disease (specify type)	____	____	____________	☐☐☐	Cols 63 65

17. Is your home air conditioned? 1-no 2-yes, window only 3-yes, central ☐ Col 66

18. What is the usual occupation of the *head* of your household? (please specify)____________________ ☐☐ Cols 67 68

____

19. What educational level has been completed by the head of your household: ☐ Col 69

1-less than 8th grade	5-college-incomplete
2-8th grade	6-college completed
3-high school-incompleted	7-graduate school
4-high school-completed	

YOU HAVE COMPLETED THE QUESTIONNAIRE
THANK YOU FOR YOUR COOPERATION

INTERVIEWER NOTE AND RECORD

20. Distance ☐ Col 70

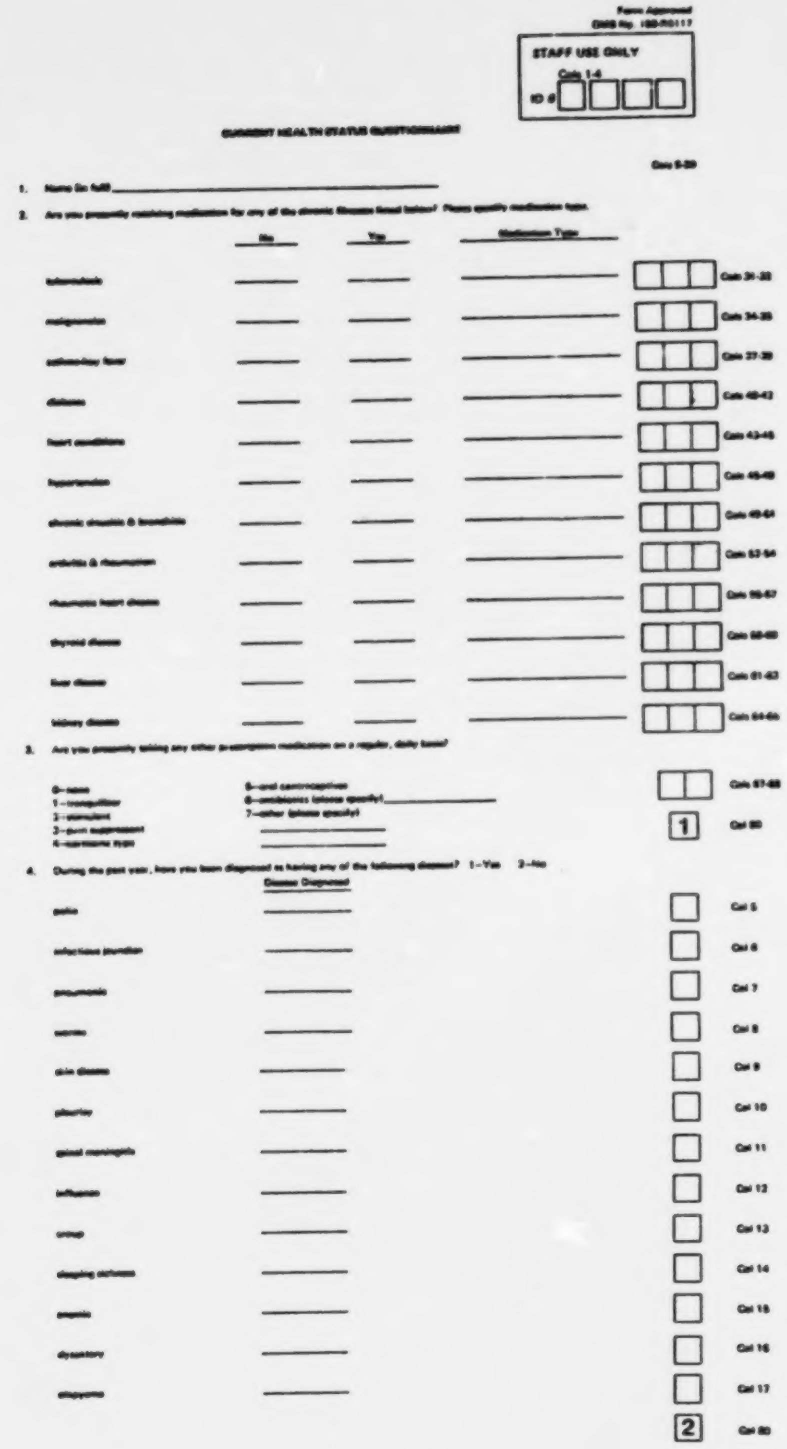
21. Sector ☐ Col 71

22 Distance to nearest:

	less than 2 blocks	less than 1 mile	one mile or more		
a. freeway, expressway or turnpike	1	2	3	☐	Col 72
b. other major multilane traffic artery	1	2	3	☐	Col 73
c. large industrial operation	1	2	3	☐	Col 74

23 IMNOWO 1 2 3 4 5 6 $\boxed{2}$ Col 80

Figure 4. (continued)



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STAFF USE ONLY
Cols 1-4
ID # ☐☐☐☐

CURRENT HEALTH STATUS QUESTIONNAIRE

Cols 5-30

1. Name (in full) ____________________

2. Are you presently receiving medication for any of the chronic illnesses listed below? Please specify medication type.

	No	Yes	Medication Type		
tuberculosis	____	____	________	☐☐☐	Cols 31-33
malignancies	____	____	________	☐☐☐	Cols 34-36
asthma-hay fever	____	____	________	☐☐☐	Cols 37-39
diabetes	____	____	________	☐☐☐	Cols 40-42
heart conditions	____	____	________	☐☐☐	Cols 43-45
hypertension	____	____	________	☐☐☐	Cols 46-48
chronic sinusitis & bronchitis	____	____	________	☐☐☐	Cols 49-51
arthritis & rheumatism	____	____	________	☐☐☐	Cols 52-54
rheumatic heart disease	____	____	________	☐☐☐	Cols 55-57
thyroid disease	____	____	________	☐☐☐	Cols 58-60
liver disease	____	____	________	☐☐☐	Cols 61-63
kidney disease	____	____	________	☐☐☐	Cols 64-66

3. Are you presently taking any other prescription medication on a regular, daily basis?

0—none
1—tranquilizer
2—stimulant
3—pain suppressant
4—[illegible] type
5—oral contraceptive
6—antibiotics (please specify) ________
7—other (please specify)
____
____

☐☐ Cols 67-68

1 Col 80

4. During the past year, have you been diagnosed as having any of the following diseases? 1—Yes 2—No

	Disease Diagnosed		
polio	________	☐	Col 5
infectious jaundice	________	☐	Col 6
pneumonia	________	☐	Col 7
worms	________	☐	Col 8
skin disease	________	☐	Col 9
pleurisy	________	☐	Col 10
spinal meningitis	________	☐	Col 11
influenza	________	☐	Col 12
croup	________	☐	Col 13
sleeping sickness	________	☐	Col 14
[illegible]	________	☐	Col 15
dysentery	________	☐	Col 16
empyema	________	☐	Col 17

2 Col 80

Figure 5. Current health status questionnaire.

(continued)

5. Have you experienced any of the following symptoms during the past three months? At present?

	Experienced during past three months		Experiencing at present			
	Yes	No	Yes	No		
severe headache not relieved by aspirin	___	___	___	___	☐☐	Cols 5-6
severe dizziness	___	___	___	___	☐☐	Cols 7-8
severe pain in bones and joints with high fever	___	___	___	___	☐☐	Cols 9-10
severe weight loss	___	___	___	___	☐☐	Cols 11-12
severe night sweats	___	___	___	___	☐☐	Cols 13-14
hemorrhagic rash	___	___	___	___	☐☐	Cols 15-16
canker sores around mouth	___	___	___	___	☐☐	Cols 17-18
yellow eyeballs	___	___	___	___	☐☐	Cols 19-20
sore throat	___	___	___	___	☐☐	Cols 21-22
cough	___	___	___	___	☐☐	Cols 23-24
cold	___	___	___	___	☐☐	Cols 25-26
skin rash face	___	___	___	___	☐☐	Cols 27-28
arms & legs	___	___	___	___	☐☐	Cols 29-30
body	___	___	___	___	☐☐	Cols 31-32
diarrhea	___	___	___	___	☐☐	Cols 33-34
bloody diarrhea	___	___	___	___	☐☐	Cols 35-36
bloody urine	___	___	___	___	☐☐	Cols 37-38
burning on urination	___	___	___	___	☐☐	Cols 39-40
nausea	___	___	___	___	☐☐	Cols 41-42
vomiting	___	___	___	___	☐☐	Cols 43-44
yellow skin	___	___	___	___	☐☐	Cols 45-46
pain in chest on deep breathing	___	___	___	___	☐☐	Cols 47-48
weakness of arms or legs	___	___	___	___	☐☐	Cols 49-50
cough up blood	___	___	___	___	☐☐	Cols 51-52
stiff neck with fever	___	___	___	___	☐☐	Cols 53-54
stiff neck with rash	___	___	___	___	☐☐	Cols 55-56
general weakness	___	___	___	___	☐☐	Cols 57-58
draining ear	___	___	___	___	☐☐	Cols 59-60
fever above 102°F	___	___	___	___	☐☐	Cols 61-62
severe trouble with teeth	___	___	___	___	☐☐	Cols 63-64
colicky pains in abdomen	___	___	___	___	☐☐	Cols 65-66
brown urine	___	___	___	___	☐☐	Cols 67-68
shortness of breath	___	___	___	___	☐☐	Cols 69-70
convulsions	___	___	___	___	☐☐	Cols 71-72
unconsciousness (not due to blow on head)	___	___	___	___	☐☐	Cols 73-74
					3	Col 80

YOU HAVE COMPLETED THE QUESTIONNAIRE. THANK YOU FOR YOUR COOPERATION

Figure 5. (continued)

Health Survey Participant Questionnaire, shown in Figure 4, served to obtain pertinent background information on each participant. The Current Health Status Questionnaire, shown in Figure 5, served to obtain more detailed health information on each participant at specific intervals during the study period.

Survey Design

Development of the specific survey design for the study required an initial site visit to survey the study area. With the information gathered and contacts accomplished during the initial site visit, specific survey sectors were defined and a survey team was recruited. Background survey materials were developed and the field survey team was assembled and trained. These activities are described in the following sections.

Initial Site Visit–

An initial site visit was accomplished during August 1974 by the two project staff members responsible for design of the household survey. The study area was canvassed and each neighborhood was examined regarding the potential for performance of house-to-house surveys and recruitment of participants. Detailed maps of the proposed survey areas were acquired and visits were made to the municipal and county governments under whose jurisdiction the survey would be accomplished to obtain permission for house-to-house survey work. Accordingly, preliminary contacts were accomplished with each of the following to obtain clearance for the surveys:

Cook County Sheriff's Office
DuPage County Sheriff's Office
Hoffman Estates Village Officials
Elk Grove Village Officials
Schaumburg Village Officials
Itasca Village Officials
Roselle Village Officials
Rolling Meadows Village Officials

A temporary manpower firm with offices in the area, Manpower, Inc., was contacted and arrangements were made for an on-site coordinator. The local firm agreed to recruit survey field workers for the study and arrangements were made for an initial training meeting with all field workers at a time immediately preceding the first household survey in September 1974.

Preparations for the Survey–

With the information obtained during the initial site visit, the 21 specific survey sectors presented in Figure 2 in Section 4 were defined.

A scheme was developed for payment of survey workers which included an incentive bonus for recruitment of participants. With this scheme, each interviewer would be paid $3.00 per hour. The interviewers were to be hired through the services of Manpower, Inc., for a fee of 50%. The effective cost to SwRI was to be $4.50 per hour. It was estimated that 50 completed questionnaire forms could be collected in a 40-hour work week by each interviewer. To accomplish the desired 1,050 surveys in a one-week period would require 21 interviewers at the estimated rate of 50 completed surveys per week. A bonus of $1,000 was established for an incentive to the workers to recruit study participants. A $4.00 bonus per participant questionnaire form collected would be paid to the survey worker for each participant up to the 250 participants desired. If more than 250 participants were attracted to the study, the $1,000 would be prorated accordingly.

Instruction sheets for the survey workers and a handout sheet were prepared for use during the survey. Examples of these backup materials and a news release for dealing with the news media are presented in Appendix B, Survey Backup Materials. Plans were made to pay each survey participant $12.50 for each of four sampling periods and a bonus of $25 for completing all four periods. Thus, each participant could receive a total of $75. Because participants were desired only for inner sectors, the instruction sheets developed for interviewers are labeled Participant Sectors and Outlying Sectors, respectively.

The Survey Team–

Twenty-one survey workers were recruited and trained, including one on-site coordinator, Mrs. Carol MacArthur. Mrs. MacArthur remained active as the study on-site coordinator throughout the remainder of the study and was instrumental in making arrangements for all of the survey and sampling periods.

Each survey worker was assigned a specific sector, and was instructed to perform 50 house-to-house surveys within the sector during a one-week period. The workers were instructed regarding the appropriate attire, manners, and procedures to follow in performing the survey.

Performance of Baseline, Additional Baseline and Operational Household Surveys

Arrangements were made with two newspapers in the Chicago area to provide public awareness regarding the study and create a climate of understanding and public acceptance of the survey activities. Articles were published during September 1974 in the Chicago Tribune and in the Arlington Heights Herald, a newspaper specifically serving the study area. During subsequent survey periods in 1975 and 1976, the Arlington Heights Herald again published articles regarding the study.

The baseline household surveys, accomplished in September 1974, were directed on site by a member of the SwRI project staff and coordinated by Mrs. Carol MacArthur. One field survey team member was assigned to each of the 21 study sectors and was instructed to obtain fifty completed Household Health Survey Questionnaire forms at random within the assigned sector.

Using these procedures, 1,043 household surveys were accomplished by the field survey team. Of these surveys, 521 households in the inner region were asked to participate in the individual health survey. The response was extremely high, with 471 individuals volunteering to participate in the study. This is an exceptionally high rate of response to a public health survey requiring delivery of biological samples.

From the 471 individuals volunteering for participation in the study, some 250 individuals were selected as participants. The volunteers were divided by sex and age into four groups. In selecting the participants, an attempt was made to have an equal number of participants in each of the four age groups, and an equal number of each sex in each age group. Table 4 shows, by sex, the number of participants selected in each of the study age groups.

TABLE 4. INITIAL PARTICIPANTS RECRUITED IN SEPTEMBER 1974

Age Group (yr)	Number of Participants	
	Male	Female
0-6	22	28
7-18	33	25
19-45	40	52
46+	15	16
Total	110	121

The scheduled start-up of the plant was delayed past the September 1975 date of the originally scheduled operational period survey. Also, during the intervening period of time, a new community of residents was established very near the plant site, in the portions of Sectors 1 and 11 within 1/2 km of the plant. This is the community of Lexington Green and was designated Sector 22. Because of the nearness of these residents to the plant site, they were viewed as superb subjects for study participants.

The delay in the start-up date of the plant operations provided a possibility for baseline household surveys to be conducted in September 1975 in the new area and recruitment of an additional set of study participants. Accordingly, in September 1975 approximately 75 household surveys were accomplished in the Lexington Green area and more than 40 new participants were recruited for the study. These participants were added to the complement of those recruited during the initial baseline survey, and the combined group of participants was studied from that time forward. The number of additional participants obtained in each of the study age groups is shown, by sex, in Table 5.

TABLE 5. ADDITIONAL PARTICIPANTS RECRUITED IN SEPTEMBER 1975

Age Group (yr)	Number of Participants Male	Female
0-6	1	7
7-18	1	4
19-45	13	15
46+	3	7
Total	18	33

In September 1976, the operational period survey was accomplished in the 22 study sectors with 1,104 household surveys . No participants were recruited during the operational period survey, as only participants from earlier phases were required. Accordingly, the Household Health Survey Questionnaire form was modified so not to include a question regarding participant recruitment.

The September 1976 household survey was arranged almost wholly through the work of the on-site coordinator, Mrs. Carol MacArthur. Members of the project staff worked closely with Mrs. MacArthur to coordinate her activities. Contacts were again made with all pertinent local governments and clearance was established for the required survey activities. With the help of local temporary manpower firms, Mrs. MacArthur recruited and trained 22 survey workers for use in the survey and supervised their activities during the performance of the survey.

ENVIRONMENTAL SAMPLING

Organization Overview

The collection of environmental samples such as soil, air, water, and sewage effluent over the rather large study area (6-kilometer diameter circle) required notification and obtaining permission from the following municipalities:

—Schaumburg, Illinois
—Elk Grove Village, Illinois
—Roselle, Illinois

—Hoffman Estates, Illinois
—Itasca Village, Illinois
—Rolling Meadows, Illinois
—Cook County, Illinois
—DuPage County, Illinois
—Metropolitan Sanitary District of Greater Chicago (MSD)
—Forest Preserve District of Cook County, Illinois

When required, formal permit agreements, certificates of insurance, and release of liability statements were entered into or obtained from the municipality, governmental agency, or private citizens.

In the case of air sampling, when electric power was required, private residences were utilized whenever wind conditions permitted. The owner of the residence was paid fifteen dollars for access to his property and for the use of electric power. When no permanent source of power was available, gasoline-powered generators were used.

Because of the diversity of tasks to be accomplished, two on-site managers, microbiological and heavy metals, were designated to direct the activities of the special collection teams.

The microbiological manager had the overall responsibility for the field operation. His special duties were to direct the activities of the microbiological collection teams in the collection and processing of the soil, air, and water samples to be used for bacteria and virus determinations. In addition, he established daily sites for the air samplers, taking into consideration wind and weather conditions for that particular day.

In some cases, it was more cost effective for the two collection teams to collect samples simultaneously at the same site. In such cases close cooperation between the two groups was effected. The microbiological collection team composed of up to six individuals were given extensive training for up to three days on the proper procedures and care required in air sampling for bacteria and viruses. This instruction was given by a professional microbiologist. These people were all hired through a temporary employment agency and all but one were either undergraduates or graduates in the field of science.

The heavy metals manager had the responsibility for directing the personnel involved in the air, water, and soil sampling for heavy metal determinations. The heavy metal sample collection team was composed of two members with one a professional chemist from SwRI and the other a person hired on site through the temporary employment agency. Training for this job was usually accomplished during the first day of sampling.

Air Samples

Sampling Design and Protocol–

In sampling periods 1 and 2, four portable air sampling stations were used to take 30-minute to 24-hour samples along the wind's direction on each of the seven sampling days from October 13-19, 1974 and January 26-February 1, 1975. These samplers were located at any four of the five upwind and five downwind distances from the plant (5, 50, 500, 1600, or 5000 meters). The sampler location design shown in Figure 6 was used depending on the daily predicted predominant wind direction.

During the first two sampling periods a comprehensive monitoring program was conducted for seven consecutive days beginning on a Sunday preceding the week the subjects were sampled. These air samples were monitored for trace metals and bacterial and viral pathogens. All air samples were taken with regard to wind direction and distance from the water reclamation plant. Five distances were used to describe the pattern of the materials from this plant (5, 50, 500, 1600, and 5000 meters).

	Pattern		
Predicted Wind Direction	Upwind Air-Sampler Locations	Downwind Air-Sampler Locations	Maximum Pattern Frequency
East (Crossing I90 within 1 mile of site)	UOUT, U-IN	50, 1600	1
North/West/South		5, 50, 500, 1600	2
North/West/South		50, 500, 1600, 5000	2
North/West/South	U-IN	5, 50, 500	1 or 2
North/West/South	U-IN	500, 1600, 5000	1

The location distance codes in the chart are relative to the center of the aeration basin. They should be given the following interpretation:

UOUT:	Upwind-out. Approximately 1600 meters upwind.
U-IN:	Upwind-in. About 200-800 meters upwind.
5:	Downwind 5 meters.
50:	Downwind 50 meters.
500:	Approximately 500 meters downwind.
1600:	Approximately 1600 meters downwind.
5000:	Approximately 5000 meters downwind.

Figure 6. Air sampler location design.

Sampling points along these circles were selected with regard to direction. Four air samplers were used for collection of ambient air samples and one of the air samplers was always located on the upwind side with the other three on the downwind side. The upwind station was intended to describe the background levels of microorganisms and trace metals.

For sampling off the plant grounds, 24 sampling sites were preselected to describe the windrose pattern at 1.6- and 5-kilometer distances from the plant. These sites were located based on the windrose patterns for the time of year being sampled. In addition, 12 additional sites were preselected in case the wind direction was different than that predicted by the national windrose pattern charts for the area. The sampling sites were changed each day to follow the wind direction. If the wind direction changed drastically during any one sampling period, attempts were made to move the samplers.

The actual distances and the sampling direction each day were recorded in a log book to allow a more accurate statistical analysis of the air sample data. If the sampling patterns were repeated on two different days, attempts were made to sample along two different wind directions on those days. Hence, the actual air sampling schedule followed on a given day was not assigned until the day before when a reliable wind direction for that day could be forecasted.

Expanded aerosol sampling was recommended for sampling period 5 operational environmental survey primarily because of the importance of the findings in the period 4 sampling. Preliminary data obtained during the winter operational survey indicated that the levels of some bacteria and viruses near the plant might be as high or higher than levels seen near the spray irrigation facility in Pleasanton, California. The design and protocol for sampling in periods 4 and 5 were the same except that in period 4 only one high-volume microbiological sampler was available, while in period 5, simultaneous sampling at six stations was accomplished.

Increased aerosol sampling was recommended because of the improved methods of sampling and analysis that were developed in the recently completed Pleasanton environmental sampling program. The Pleasanton study indicated that several high-volume samplers operating simultaneously were much more effective in describing the levels of microbiological aerosols. The availability of these high-volume samplers (LEAP and Litton) also made the proposed expansion of Chicago aerosol sampling feasible.

A second reason for recommending the expansion of aerosol monitoring was that the project scope of work called for two operational samples to be collected around the Egan plant; one during the winter, and one during the summer. However, the John E. Egan plant was not in full operation at the time of the winter sampling and it was felt that a thorough summer aerosol sampling program would provide much essential biological aerosol information that was lacking.

Basically, the proposed plan for expanded aerosol sampling during the summer operational survey was to perform ten aerosol sampling runs over a seven-day period using six high-volume samplers (LEAP and Litton type) operating simultaneously, with one upwind and five downwind. This basic design of sampling was similar to that of the study near Pleasanton, California, and the recommended analytical protocol for both aerosol and effluent samples was identical. This was an increase over what had been utilized in previous surveys at the John E. Egan plant and represented an increase in the scope of work of the study. In this proposed expansion a total of 60 aerosol samples was collected. Each of these 60 aerosol samples was analyzed for total plate count, total and fecal coliform, coliphage, pathogenic bacteria — salmonella, shigella, pseudomonas, streptococcus, proteus, viruses — via three- and five-day counts — polio, adeno, coxsackie, and echo.

A comparison was made of the aerosol sampling analyses results obtained at the Egan plant in the winter sampling and at the Pleasanton spray irrigation site. From this comparison it was projected that, because of diffusion and biological decay, the maximum feasible downwind sampler distance from the Egan plant at which statistically usable biological analysis results would be obtained was approximately 200m during the day and 400m at night. It was recommended that these maximum distances replace the 5000m maximum sampler distance of the existing aerosol sampling protocol. Because the simultaneous aerosol samplers were located at varying distance intervals under the proposed plan, it was still possible to project the biological aerosol concentrations out to 5000m using a suitably calibrated dispersion model. It should be noted that the nearest residential areas to the Egan plant are now within 400m of the aeration basins.

Extra days were included above the actual seven days of sampling as a precaution for contingencies such as rain, other environmental conditions, or equipment failure which might have prevented sampling or made it necessary to abort sampling runs already initiated. Four runs were made in the early afternoon (Stability Classes A-C with high solar radiation), three runs in the early morning (Stability Classes C-F with low solar radiation), and three runs at night (Stability Classes C-F with no solar radiation).

The five downwind aerosol samplers were arranged along a sampler line determined by the mean wind direction measured just prior to actual setup of the samplers. This compass direction would radiate out from the center of the aeration basins. Sampler location distances from the edge of the aeration basin fell into the following distance ranges:

Distance Ranges for Location of Downwind Samplers (Meters)
15- 30
50- 75
100- 150
200- 400
600-1200

An upwind station was located directly upwind at a distance of 500 to 1600 meters for each run. Exact distances for both upwind and downwind stations were recorded for each aerosol run.

Distance ranges were given due to the fact that exact distances were dictated by actual wind direction and resulting interferences due to physical obstructions such as buildings, ponds, highways, trees, etc..

Duplicate samples were collected with samplers set up next to each other at the 15-30 meter distance during one afternoon run and at the 50-75 meter distance during one night run. All other aerosol runs were conducted using a single sampler at each of the five distance ranges mentioned above. In the event wind direction and physical obstructions prevented placement of samplers at one of the distance ranges, the sampler in question was placed at the nearest unobstructed point.

The procedure for field measurement of wind direction determines the mean wind direction, to the nearest 5°, from the field wind measurement strip chart recorder just before the aerosol sampling run.

To obtain the wind stability class in the field, one or more of the following procedures were followed (listed in decreasing order of reliability):

—from the temperature difference instrumentation (4.7m vs 0.5m):

Reading	Interpretation	Stability Class
+	Stable	E or F
0	Neutral	D
—	Unstable	A, B or C

—from the solar altitude, wind speed, and cloud cover as described by D. B. Turner in Atmospheric Dispersion Estimates (Table 6).

TABLE 6. KEY TO STABILITY CATEGORIES

Surface Wind Speed (at 10 m), $msec^{-1}$	Day			Night	
	Incoming solar radiation			Thinly Overcast or ≥ 4/8 Low Cloud	≤ 3/8 Cloud
	Strong	Moderate	Slight		
2	A	A-B	B		
2-3	A-B	B	C	E	F
3-5	B	B-C	D	D	E
5-6	C	C-D	D	D	D
6	C	D	D	D	D
The neutral class, D, should be assumed for overcast conditions during day or night.					

—from the variability in wind direction as described in the following table:

Allowable Variations in Wind Direction for Stability Classes

Stability Class	Allowable Standard Deviation About the Mean Wind Direction (degrees)
A	± 25
B	± 20
C	± 15
D	± 10
E	± 5
F	± 2.5

A sampling run was not set up if rain or other environmental conditions existed that would interfere or affect the authenticity of the sampling run.

If it was decided to sample, the aerosol run was set up and the wind direction and stability were rechecked. Sampling occurred only if the wind direction mean remained fairly constant and if no marked changes in meteorological conditions were expected over the next 30 minutes.

The run was continued as long as there was no marked change in the mean wind direction prior to the completion of 15 minutes of sampling. If during the first 15 minutes the mean wind direction shifted more than 45° from the direction at the beginning of the run, then the samplers were no longer downwind of the spray line and the run was aborted.

The aerosol samples were processed and shipped for analysis unless one or more of the following conditions occurred:

—Based on the field strip chart recorder and temperature difference instrumentation, there was sufficient change in the wind direction and/or stability that three or more samplers experienced less than 15 minutes of actual downwind sampling.

—Aerosol samples were obtained from less than three of the downwind samplers.

—No upwind aerosol sample was obtained. If the upwind (background) sampler should malfunction during the run, another upwind sample could have been substituted provided it was taken within two hours after run completion and wind direction had not reversed.

Sample Collection Procedures for Metals and Microbiological Aerosol Samples– The collection of air samples was performed to define metal concentrations (lead, zinc, copper, cadmium, and mercury) before and after the treatment plant went into operation.

The equipment used to collect the air samples consisted of high-volume particulate samplers of standard design. Equipment from three different manufacturers (Staplex, BGI, and General Metal Works) were used on this study. Basically, each consisted of a blower with an 8" × 10" holder for the filter. A weatherproof unit composed of wood or aluminum, depending on the manufacturer, protected the filter and the motor from the weather. Prior to sampling operations in the field, each high-volume sampler was calibrated with a series of resistance plates. A secondary calibration curve was then developed for each sampler based on the primary calibration curve for the resistance plates.

Glass fiber filters, Type A (20.3 × 5.4 cm), without an organic binder (Gelman Instrument Co.), were used for the particulate collection media. A light table was used for visual inspection of each filter for thickness variation and pinholes. Filters passing this test were then sequentially numbered and separately placed in clean polyethylene bags. After sample collection, these filters were analyzed for lead, zinc, copper, and cadmium levels.

Sample collection for mercury in air involved the use of three different methods during different phases of the project work.

The charcoal tube method developed by Scarengelli(18) was used for all phases of this project except the last post-operational period. For that period the silver wool absorption procedure developed by Long(19) was used. This method was also complemented by use of the potassium permanganate procedure of Gardner.(20)

Five distances were used to describe the pattern of metals from the treatment plant — 5, 50, 500, 1600, and 5000 meters. Sampling points were identified along these grid lines and where possible homeowners near the identified sites were contacted. The placement of the samplers in the homeowner's yard provided security, a source of electricity, and, most importantly, the close-hand monitoring of ambient air levels within the neighborhood. Twenty-eight preselected sampling sites were used off the plant grounds and ranged from 500 to 5000 meters from the center of the primary aeration basin. Each site selected had the minimum amount possible of obstructions that might alter the air flow pattern from the treatment plant.

Before the start of each day of sampling, the weather bureau at O'Hare Airport was called to find out the prediction for wind direction during the following 24-hour period. Based on this prediction and the current wind conditions at the plant site, four sampling sites were identified for that 24-hour period. One station was located upwind and a minimum of three stations were located downwind. Generally, the stations located on the plant site were set up first, followed by the stations in the surrounding community.

At each site, one high-volume and one mercury sampler were set up. A clean, numbered glass fiber filter was placed in the high-volume sampler. Next, a precleaned, numbered mercury collection tube was connected to a vacuum pump with a critical orifice. The high-volume sampler and the mercury pump were then started and the exhaust from them was directed downwind. A 10-minute warm-up period was allowed for each sampling unit motor to come to operating conditions. Start-up time, flow rate, filter and tube numbers, sampling unit identification, and wind conditions were recorded for each site. Approximately 12 hours later, each sampling site was visited to ensure there were no problems with the samplers.

At the end of the 24-hour sampling, the flow rate for each sampler was noted as was the time the samplers were turned off. The glass fiber filters were removed from the sampler and folded with the particulates on the inside. The filter was then returned to its polyethylene bag and labeled appropriately. The mercury collection apparatus was similarly sealed and labeled with site number, day, date, and unique sample identification number. The samplers were then set up again either at the same site or moved depending on the wind direction. This process of setting up and maintaining the samplers at the designated downwind and upwind distances continued for a total of seven consecutive sampling days for each sampling period. At the end of the sampling period, the collected samples were sent to the San Antonio laboratories for analysis.

Samples were obtained for bacteria using both Andersen 2000 samplers and high-volume electrostatic precipitators (LEAP and Litton). Samples for viruses were obtained using a one cfm impinger. The samplers are described below.

The Andersen 2000 is a two-stage sampler designed to use commercially available standard 100-mm Petri dishes pre-filled with 20 ml of sterile bacteriological agar. The sampler is designed to draw one cfm of air when attached to a vacuum source. The following types of media were used in the Andersen 2000 samplers.

—blood agar
—MacConkey agar
—Lowenstein - Jensen
—Salmonella - Shigella
—Middlebrook 7H10

Two types of large-volume air samplers were used for collecting biological aerosol samples. The first type was the LEAP Sampler, Model 3440, manufactured by the Environmental Research Corporation of St. Paul, Minnesota; the second type was the Litton Model M Large-Volume Air Sampler, manufactured by Applied Science Division, Litton Systems, Inc., Minneapolis, Minnesota.

The two different types of samplers are designed to collect airborne particles and concentrate them into a thin, moving film of liquid. The samplers are basically electrostatic precipitators. Aerosol is drawn into the sampler through a converging nozzle and passes through the center of a high-voltage plate, then flows radially between the plate and a lower rotating collection disc. A ring of needles concentric with the air inlet emits a continuous corona which imparts an electrical charge to the particles. The electrical field then provides the driving force to precipitate charged particles onto the lower disc.

The medium used in these samplers was BrainHeart Infusion broth (BHI) with 0.1-percent Tween 80. This was selected based upon the results of a transfer media study conducted as a part of "Evaluation of Health Effects Associated with the Application of Wastewater to Land"(21) where similar samples were obtained.

The following operating procedure was used in obtaining aerosol samples with the high-volume samplers (LEAP and Litton):

1. After sampling site was selected, the sample table was set up and ensured to be level. The generator was set off to one side to the full length of the extension cord and the gas and oil levels were checked before starting.

2. All high-volume air samplers were cleaned in the field immediately before use by the following procedure:

—scrubbing the rotating plate with Alconox or Clorox solution using a Kimwipe;

—running Clorox solution through the lines and onto the ground;

—running thiosulfate solution through the lines and onto the ground;

—giving a final rinse by running sterile water through the lines; and

—during cleaning, the liquid pump and the air blower should both be on but the high voltage power supply should be off.

3. After the sampler was cleaned, the BHI medium bottle was removed and the level of the liquid marked. The medium was run into the high-volume sampler and when the medium began to come out the return lines, the liquid level on the BHI bottle was marked again. The liquid was kept at this second level throughout the run by adding sterile water as necessary.

4. The plate was ensured to be wetting properly and then the liquid flow rate was set at 12 ml/min. The air flow rate was adjusted to read 1,000 lpm. Samplers were checked for about one minute prior to the start of the sample run with the high voltage supply on to ensure that no arcing or power problems existed.

5. When the signal to start sampling was given the high voltage power supply was turned to 14kv and a 30-minute sample was taken.

6. Careful attention was paid to the level of the BHI and to excessive arcing.

7. At the end of 30 minutes, the high voltage power supply was turned off and the supply line pulled out of the BHI reservoir. The liquid pump and the air blower were run until all the liquid was collected in the original bottle. The level was made up to the original 100 ml mark on the bottle with sterile water.

8. The cleanup procedure was repeated.

The aerosol particle-size sampling protocol was to perform two particle-size sampling runs during the period from September 30 through October 8, 1976. Six-stage Andersen viable particle samplers were located at one upwind and five downwind stations for simultaneous collection of total coliform organisms on one run and for standard plate count on the second run. Distance ranges for location of the samplers were the same as for high-volume samplers. Sampling times were determined by a preliminary run for which the sampling times were one minute for samplers located out to 30 meters, five minutes for samplers located out to 75 meters and 15 minutes for the more distant stations. Plates from this run were incubated and counted only if all stations or plates were not overgrown. If all plates were countable, the run was considered valid and the second sampling run was conducted using the same sampling times. If the majority of the plates were not countable, sampling times were altered as needed for the second run or until two valid runs were obtained.

Air samples for viruses were obtained using a one cfm impinger. Collection of viruses from air was set up by using a side-arm flask with a one-hole stopper through which passed a short length of glass tubing with a funnel on the upper end and a capillary tip on the lower end extending into a known volume of BHI medium. A source to produce a vacuum was attached to the side-arm and the diameter of the capillary regulated the flow of air which passed through the medium in which the viruses were collected. One cfm rotameter was also located between the flask and the pump so accurate flow measurement was obtained.

Four of these samplers were operated along with the samplers for bacteria.

Mixed Liquor Samples from Aeration Basin

A daily composite mixed liquor sample was collected from the second stage aeration basin during Period 4 and a daily sample was collected from the first stage aeration basin during Period 5. A model WM-5-24 Sigmamotor sampler was used for the collection of the aeration basin sample. The 24-hour composite sample was split into two equal parts during the collection process. The first part consisted of approximately 150 ml collected every fifteen minutes and placed in a 20-liter carboy which had been sterilized prior to use. The second part consisted of approximately 150 ml collected every fifteen minutes and placed in a 20-liter carboy which had been washed and rinsed with nitric acid prior to use.

The first part was analyzed for microorganisms while the second part was analyzed for chemicals (trace metals and TOC). The carboys and samples were maintained at 40°F in a refrigerator located below the sampler. After every 15-minute sampling period, the automated sampler purged the collecting tubes between the sampling point and the carboy. Every morning the collected samples were removed and an empty sterilized carboy and an empty acid-washed carboy were placed in the refrigerator for the next daily composite sample. The collection tubes for the microorganisms were replaced on a daily basis and autoclaved prior to use. The collection tubes for the chemicals were similarly replaced and acid rinsed prior to use.

During the Period 5 sampling, an additional sample was taken from the first stage aeration basin. This sample was a one-hour composite sample that was started fifteen minutes before each aerosol run and terminated fifteen minutes after each aerosol run. This sample was analyzed for microorganisms only and served as an indicator of what the characteristics of the first stage aeration basin were during each aerosol run.

All samples collected were kept at 40°F during shipment and analysis was begun within 24 hours after collection.

Soil Samples

Three separate surface soil samples were collected for trace metal, bacterial, and viral analyses. A total of 50 samples for each of these three types of analyses were collected during each sampling period. The samples for trace metals were collected using a plastic digging device to collect several grams of surface soil. This sample was placed into a polyethylene container which had been prewashed to remove trace metals. The container was sealed and kept frozen until analyzed.

The soil samples for bacterial and viral analyses in Periods 1 and 2 were taken in the following manner. Using a sterile digging instrument, a surface soil sample of several grams was taken and placed in a vial containing thioglycolate solution and shaken. The material was then shipped on wet ice on a daily basis to San Antonio. The soil sample for virus determination was collected in the same manner as the samples for bacteria except that the sample was frozen immediately after collection and kept frozen until analyzed. No solution was added to the soil sample for viruses.

During Periods 4 and 5, larger soil samples were collected for bacteria and virus analyses. The samples were collected in the same manner as in Periods 1 and 2 with the exception that no thioglycolate solution was used to preserve the bacterial samples.

The soil samples for trace metal, bacterial, and viral analyses were collected on the same day, sometime during each of the four sample periods. The samples were not collected during periods of precipitation. The locations for collection of soil samples were designed to describe the windrose pattern, but they included the preselected air sampling sites described earlier. The remainder of samples were taken along radial grids to fill in the gaps between air sampling sites to better define the windrose pattern.

Water Samples

Water samples were collected from ponds, lakes, and streams located within a five-kilometer radius of the water reclamation plant. A total of 10 water samples were collected during each sample period and analyzed for trace metals, bacteria and virus. For Salt Creek, water samples were taken upstream and downstream from the water reclamation plant. Water samples were taken on a single day during each of the four sample periods.

Approximately 250-ml samples of water were collected for trace metal analysis in polyethylene containers which had been specially washed for this purpose. These samples were frozen and kept frozen until analyzed. A separate sample was collected for bacterial analysis using asceptic techniques. The bacterial samples were collected by a grab technique in which one liter of water was collected. These samples were shipped on the same day they were collected.

Water samples for the virology study were collected in a one-liter container. The one-liter sample was collected in a wide-mouth screw-cap plastic bottle and frozen until analyzed in the laboratory.

Meteorological Sampling

At the plant site a meteorological station was set up and operated during the environmental sampling periods. During the air sampling runs information was recorded for wind speed and direction, temperature, humidity, and solar radiation. Values from these instruments were used in aerosol sampling runs and to describe the meteorological conditions during the remaining time in the sample periods.

Supplemental climatology data was obtained from the weather bureau maintained at O'Hare Airport located approximately eight miles east-southeast of the Egan Plant. Prior to starting a sampling run, whether for aerosol or particulate collection, the O'Hare weather people were called. A prediction for wind direction and speed was obtained for the subsequent few hours to determine if conditions were applicable for aerosol sampling. The high-volume particulate samplers were set up based on the wind prediction for the subsequent 24-hour period. This information about the projected wind conditions and possible precipitation patterns was used in conjunction with the conditions at our weather station maintained at the Egan plant. These two sources provided the criteria for setting up samplers and/or moving them if necessary.

The equipment used to obtain and record the meteorological conditions in the study area was set up at the Egan treatment plant. Measurements for wind speed and direction, solar radiation, temperature, and humidity were recorded on strip chart recorders that were an integral component of each piece of equipment.

Wind speed and direction were monitored using a Model 6405 Field Recording Wind Set purchased from R. M. Young Company, Traverse City, Michigan. The windvane and cup anemometer were mounted on top of a five-meter pole. The range of the windvane was 360° mechanical, 342° electrical (5% open), with continuous rotation. The anemometer was operated in the 0 to 50 mph range with a threshold of less than 1.5 mph. The recorder-translator was powered by a 12-volt, 60 ampere-hour battery.

Solar radiation was monitored using a Model B-5-3850A Recording Pyrheliograph available from TechEcology, Sunnyvale, California. This instrument with a sensitivity of 0.1 gram-calorie per square centimeter was located adjacent to the weather tower.

The temperature-humidity instrument was placed in a shelter adjacent to the weather tower. The Hydrothermograph Model B-5-594 available from TechEcology has a temperature range from —20° to 110°F. with an accuracy of ± 1°F. The humidity element has a range between 20% and 95% RH with a ± 3% accuracy.

CLINICAL SPECIMEN SAMPLING

Organizational Overview

The design of the human sampling phase of this project required that those individuals selected as subjects would remain with the project until all human tissue sampling was completed. During the two-year sampling period, human tissue samples were collected before and after the treatment plant went into operation. Each subject then was his own control and the necessity of having all of the subjects remain in the program was removed.

Because the study site near Chicago was far removed from the Institute laboratories in San Antonio, it was necessary that an on-site coordinator be selected. The responsibilities of the on-site coordinator involving the human tissue sampling were many. One key element was the availability of a person in the study area who could maintain contact with the human subjects during actual sampling periods and in the interim between sampling periods. Because the coordinator was a resident of the area, assistance was given to the sampling team on items such as the availability of a biological sampling center for the subjects, where to find medical personnel to help with the sampling, and other details that the survey team requested.

An important consideration for continued human subject participation throughout the project was the necessity of having competent, reliable, and friendly medical laboratory technologists. Based on previous experience with human subjects, the way collection of blood was performed created a lasting impression of the whole project and more importantly whether that subject would return to give future blood samples. Competent medical technologists to collect blood for this project were located at the Alexian Brothers Hospital. With the help of Dr. James Clark, who was director of the clinical laboratories at Alexian Brothers Hospital, certain medical technologists were identified that met our criteria of being competent, reliable, and friendly technologists. These persons were approached and asked to help with the epidemiological survey.

Secondary to finding competent blood drawers was the problem of locating capable people to collect hair samples from subjects. Similar to blood collection, the proper collection of hair samples was vital to continued subject participation. Subjects would not be expected to return if hair samples were taken in such a way as to drastically alter the appearance of their hair. Yet the first concern was to collect the proper hair sample in the required amounts. Barbers and hairdressers were found in the study area who could collect the proper sample while maintaining the subject's appearance.

The nature of the project and its goals needed to be disseminated through the study area so the community would be aware of this epidemiological study and its impact upon them. Local papers serving the area were provided press releases that described the project, its goal, the study area, and reminders to the study participants of upcoming sample collection periods.

Presampling Preparation

After the selection of the human subjects, letters were sent to each individual who completed a questionnaire (Appendix C). Letters sent to those people who were not selected thanked them for their willingness to participate. They were told that their questionnaire had been set aside for the present but that they would be contacted if any vacancy occurred.

The selected subjects were notified and given a date and place where the survey team would meet with them. In this letter, mention was also made of the on-site coordinator and how she could be reached if a conflict or other problems occurred prior to meeting with the survey team.

Each subject received a collection kit that had containers for the samples to be collected at home. Prior to meeting with the subjects the sample collection kits were assembled. The kit included a brief summary of the nature of the study, a set of instructions on the proper collection of urine, feces, and sputum samples, and a portable camping toilet to facilitate the collection of the feces sample. Containers were provided for the samples and each had its own unique computer-printed label that had the subject's name, type of specimen, and an identification code for sample processing.

At the first meeting with the subjects, it was convenient to meet with them at the processing center. The sample collection kits were handed out and instructions given on the proper collection of the samples. Appointment times were also set up for them to return to the collection center with their samples and to have blood, hair, and throat swabs collected. During the subsequent sampling periods, after the subjects had familiarized themselves with the sampling routine, arrangements were made to contact them by phone. The phone call was made by the on-site coordinator to arrange a time that the collection kits could be delivered to their homes. Appointment times were also set up with the subjects as to when they should come to the processing center with their samples. This procedure of delivering the collection kits to the homes and setting up appointment times was initiated as a convenience to the subjects so they would have to come to the collection center only one time.

Sampling Protocol and Sample Collection

The proper and complete sample collection by each participant necessitated that a sampling scheme be set up to obtain the best result. Institute personnel and the on-site coordinator formed an integral team to accomplish this task. The on-site coordinator, together with help from the person designated as the biological sampling manager, set up an informal procedure so each subject received as much attention as possible. With this effort, each subject was made to feel that his cooperation was vital to the success of the program. The result was that each subject did the best he could in following instructions regarding sample collection.

The first meeting with the subjects at the collection center was to explain the objectives of the project as well as to verse each subject as to the importance of proper sample collection. During this meeting, the subjects were given ample opportunity to ask questions regarding any portion of the study. Once the subjects were fully informed, they were requested to complete an informed consent form as required by the National Institutes of Health regulations concerning human subjects. A copy of this form is included in Appendix D. Each subject was also asked to include the name of their family physician, if they so desired. Their doctor would then be notified as to the presence of pathogenic organisms in their individual samples.

After the subject had completed and signed the informed consent, he was given his own sample collection kit. The subject then set up an appointment time to return with the samples and to have the remaining samples collected by qualified technicians.

Each subject was required to collect overnight urine, fecal, and sputum samples as well as to fill out a current health status questionnaire. An instruction sheet was included with each collection kit in case the verbal instructions given when the kits were handed out were forgotten. A copy of this instruction sheet is included in Appendix E.

The night before the subject was to report to the collection center, he was instructed to begin collecting his urine in the designated container. The urine samples were collected in specially cleaned wide-mouth polyethylene containers (1/2 gallon size). The subject was cautioned against putting anything other than his own urine into the container. The urine samples were collected from approximately 5 p.m. until 8 a.m. the following morning, the day for blood testing. Each subject was instructed that once he began collecting his urine he was to continue collecting all his urine until the following morning. It was also emphasized that the first specimen upon arising in the morning must be included in the total sample. After this specimen was collected the subject was told to discontinue urine collection.

An overnight fecal sample was collected using a portable camping toilet to aid in collection. The portable toilet was provided as a convenience if the subjects desired to use it. They were instructed to begin collection of the fecal specimen the evening before their scheduled blood test. When collecting the specimen the subjects were cautioned against mixing any urine or toilet paper with the feces in the polyethylene collection container. If the subjects had a place to keep the feces and urine specimens cool they were urged to do so.

The collection of the proper sputum specimen was the most difficult sample to obtain. The subjects were told that saliva was not an acceptable specimen. A sterile polyethylene collection cup was provided for the sample and the subjects were told to open the container only when collecting their sputum. The subjects were told that a valid sputum sample must come from inside their lungs and probably could be best collected the first thing in the morning. Coughing deeply several times should produce the required sample.

Each subject was also given a Current Health Status Questionnaire to fill out for each sampling period. By filling out the form at home, the subject had a more relaxed surrounding rather than at the collection center with all its activity. The subjects were also provided extra copies of the questionnaire for them to keep a daily log of symptoms should any occur prior to the next sampling period.

Blood was collected from each subject by a qualified medical laboratory technician under the supervision of a physician. The blood was collected using sterile techniques into two 10-ml vacutainer tubes manufactured by Becton Dickinson Co., Rutherford, New Jersey. The minimal lead type (L3200XF313) containing 143 units USP sodium heparin was used for metal and hematocrit determinations. A second vacutainer that was sterilized by radiation and had no anticoagulant (SR 3200) was used to collect blood for antibody titers.

While the blood collection was maintained in as trauma-free situation as possible, it was mentioned to each technologist before collection began that some of the subjects had not previously had a venous blood sample taken. With this in mind the technologists were instructed to use their best "bedside manner" to reassure each subject and to minimize apprehension on the part of the subject. This improved "bedside manner" was most useful in collecting blood from the children on the project.

Once the blood had been drawn and properly labeled, the blood in the heparinized tube was thoroughly mixed. The sterile tube was not mixed but allowed to clot. The samples were then taken to the processing room and remained there from 30 minutes up to 2 hours before processing.

A barber and hairdresser collected the hair samples from each subject. Hair was collected from the nape of the neck and hair of 25-mm length from the scalp. The hair collectors had a sample of hair weighing one gram to match with the amount of hair collected from the subject. Each barber and hairdresser was instructed as to the proper amount and location for the hair sample. They were informed of the importance of collecting the minimum amount without drastically altering the appearance of the subject's hair style. The subjects were similarly instructed to refrain, if at all possible, from having a haircut for at least one month preceding the survey period. The hair samples collected were placed in sealable plastic bags with the proper label corresponding to the subject and the location of the sample.

The collection of throat swabs was performed by a medical technologist. Cotton-tipped applicators in sterile 16 × 150-mm screw-cap tubes (Falcon 2021) were used to collect the samples. Where necessary, tongue depressors were used so the proper sample from the back of the throat could be taken. Each subject had two cultures taken — one for bacterial determinations and the other for viral determinations. Each tube was appropriately labeled and placed in the test tube rack designated for viral or bacterial assay.

The collection center was set up to provide the subjects with a central location to drop off their samples and have the remaining samples taken. In each survey period approximately 225 subjects were processed through the center in a two-day period. This number of subjects passing through the collection center meant that an efficient operation was necessary to give each subject as much personal attention as possible while keeping the time spent at the center to a minimum.

The collection center was divided into six areas that each subject visited. Upon arriving at the center with their samples, the subjects first stop was at the "sample turn-in station." Here the survey workers checked each sample to make sure that it was properly labeled, of sufficient quantity, and that all samples were collected. An index card for each subject was kept on file to assist in the sample check-in. The subject was then given the card which he presented at each station until he had passed through all stations of the collection center. The index card had the subject's name, address, and identification number, and boxes for the survey worker to initial after each sample was taken.

Following sample check-in, the current health status form of each subject was checked. The survey worker scanned each form for completeness, accuracy, and legibility. When the questionnaire was complete, the survey worker initialed the subject's index card and showed him to the waiting area where chairs were set up. This area was adjacent to sample check-in but was removed from the remaining collection areas. This kept congestion in the sample collection rooms to a minimum.

The orderly flow of subjects through each collection station was the job of the survey worker designated as the traffic director. His job was to make sure that no collection station had a back-up of waiting subjects while another station had no subjects to sample. Most of the time the subjects met their scheduled appointment times to the minute and this reduced any waiting time. This meant that after the sample check-in and questionnaire stations, the traffic director took them immediately to one of the remaining collection stations.

The collection areas for hair, throat swabs, and blood samples were each in separate rooms off a common hallway. Chairs were provided in each room for the sampling. Extra chairs were provided in the hallway for any subjects to wait.

The hair collection room was the first area usually visited by the subjects. Four barbers or hairdressers collected the samples from the subjects. If all the barbers were busy and some people were waiting, then the subject either could wait at that area or go to another collection station. The throat swab station was the least busy and the subjects did not have any waiting time. One medical technologist could easily handle the collection of the throat swabs.

The blood collection station located adjacent to the throat swab station had four medical technologists collecting blood samples. If any problems arose in collecting blood (especially from children) then one of the four technologists assisted in the collection.

At each collection station the survey worker initialed the subject's index card in the proper box indicating that sample had been collected. The survey worker also mentioned to the subject what samples needed to be taken. When the subject had visited all of the sample collections he was directed to the last station.

At the check-out station a survey worker reviewed the subject's index card to be certain that all samples had been collected. If a sample such as feces or urine had to be dropped off later, arrangements were made as to the time and place. The second aspect of this collection station was payment of the subjects. Each subject was paid at the end of each collection period in the project. The survey worker assigned to this station was the on-site coordinator. She, therefore, could answer most of the subject's questions and if not, a member of SwRI was available to assist her. Photographs of the first sample period, both environmental and human samplings, were displayed on a poster board at the payment station. This provided the subjects with a view of the overall survey and how their participation fit in the whole survey.

At the last sampling period, the subjects were given a certificate of appreciation. This certificate was an expression of thanks on behalf of the survey team for the cooperation and participation of each participant. The certificate was printed on parchment paper and could be framed and hung in a suitable place by the subject. A copy of this certificate is attached in Appendix F.

The containers used to collect the samples required various cleaning methods and handling techniques to prevent contamination. The polyethylene containers for feces and urine collection and the blood vials used in transporting the sample were cleaned as follows. Each container was washed with a laboratory detergent (Alconox) in tap water. Then it was rinsed with deionized water and placed in an acid vat containing HNO_3 (1:1) and allowed to soak for 6 to 18 hours. After acid soaking, the items were rinsed thoroughly with deionized water and placed in a 60 °C drying oven. The dried items were then capped and stored until shipment to the survey site.

The containers used for collection of throat swabs and sputum specimens required no cleaning as they were bought from the manufacturer in sterile packages. The survey workers made certain that each container or tube was tightly closed before the sealed bags they were in were opened. This precaution was also used with the sterile tubes used in transporting the serum used for antibody titers.

The hair samples were collected and transported in Zip-Lok bags. The bags were checked by lot number to be certain that no metal contamination was present, and were then used without further cleaning.

Sample Processing

Management and Special Processing--

The nature of the sample processing required that some processing be performed at the collection center and some away from the collection center.

Teams of medical technologists were assembled at the collection center and the processing center to handle sample processing. Before any team member began working with the samples, the biological processing manager briefed all the sample processors. Emphasis was placed on the proper handling of the specimen to prevent contamination. Other points covered during the briefing included the proper container for the sample, the labeling system, and the storage of the sample after processing.

Prior to processing, the samples had labels with the subject's name, his own unique identification number and what the sample was, i.e., urine, feces, or blood. Once the sample processing began, the labels used had only the subject's identification number plus a code designating the type of further processing. Sample codes were used to distinguish blood for trace metal or antibody analyses, feces for parasite, microbiological, or trace metal analysis and urine for trace metals. The processing labels thus provided confidentiality and a means for computer processing.

At the collection center one room was set up to process the blood samples. This room, while near the collection activity, was kept closed to the subjects. The blood samples were brought to this room on a routine basis.

The urine and feces specimens turned in by the subjects at the first station were kept in closed ice chests. These samples were taken to the Hanover Park Treatment Plant laboratory where processing took place. One person was assigned to transport the samples from the collection center to the remote processing center.

Blood was collected from the subjects for metal analysis and for microbiological determinations. The samples were taken to the processing room at the collection center on a routine basis. The blood samples for the antibody titers were allowed to clot and then were centrifuged. The serum was taken off using a sterile disposable pipet (Falcon 7536), placed in a 12 x 75-mm sterile polyethylene tube (Falcon 2005) and secured with a cap. The processing label corresponding to the sample label was affixed to the tube which was then placed on dry ice.

The blood sample collected in the tube with anticoagulant was used for hematocrit and metal determinations. Each blood sample was placed on an aliquot mixer and thoroughly mixed before blood was taken for the hematocrit determination. A Clay-Adams hematocrit centrifuge was used to spin the capillary tubes. The hematocrit value was then recorded on the data sheet.

The throat swabs collected from each subject were treated with two types of growth media. The technologist taking the throat swab added Brain-Heart Infusion broth (BHI) to the tube designated for viral analysis. Thioglycollate broth was added to the tube designated for bacterial analysis. The appropriate broth was added to each tube so the cotton applicator was thoroughly moistened and some excess was in the tube. The media was added to the tube as soon after collection as possible to prevent the sample from drying out. Blank throat swab tubes were also treated with the growth media and served as quality control samples to identify any contamination.

Urine samples collected by the subjects were processed at the remote laboratory facilities. Each urine specimen was weighed and the amount recorded on the data sheet. An aliquot (175 ml) of the thoroughly mixed urine was placed in a clean polypropylene bottle. One-percent (1.75 ml) acetic acid was added and the bottle labeled and placed on dry ice.

The feces specimen required a number of steps in processing. The total sample was first weighed and the weight recorded. The specimen container was then opened and the aliquots taken. Using sterile sticks three areas of the stool specimen were sampled. Approximately one gram of sample was placed into each of three 4-dram vials. The first vial had thioglycollate broth as a bacterial nutrient, the second had BHI as a viral nutrient, and the third had merthiolate for parasite preservation. Prior to adding the feces to the merthiolate, 0.5 cc of a freshly prepared iodine stock was added to the vial. In each case, the feces added to vials was thoroughly macerated with the sterile sticks. After the vials were capped, they were vigorously shaken to promote a homogeneous solution. Each vial was then labeled and put into separate wooden racks designated for parasitic, viral, or bacterial analysis. The bacterial vials were secured in the racks and made ready for shipment. The viral samples were frozen and the parasite samples maintained at ambient temperature. The remainder of the feces specimen was frozen without any added preservative and analyzed for trace metals. These specimens were maintained under those conditions until shipment was made to the San Antonio laboratories.

One feces sample was also aliquoted into vials for a quality control check of the viral analysis. These vials were labeled similar to those used for the other subjects' samples and could not be distinguished from the actual sample labels. The only exception was that the samples were spiked with poliovirus and had unused labels prepared for subjects who did not participate during the sampling period.

The hair samples collected by the barbers and hairdressers did not require any further processing at the study site with the exception of packaging all of the bags with the hair samples into one box.

The sputum samples to be analyzed for mycobacteria were placed into insulated mailers as the samples were turned in at the collection center. The samples were sent in these mailers to the San Antonio laboratories.

Preservation and Shipment--

All the time of sample processing the shipping and subsequent storage conditions were established for each sample. The following table lists the human samples collected and the means of preservation other than chemical.

Sample Type	Analysis	Shipment Conditions
Blood	Trace metals	—78 °C
	Antibody titer	—78 °C
Urine	Trace metals	—78 °C
Feces	Bacteria	4 °C
	Virus	—78 °C
	Parasites	Ambient
Throat swabs	Bacteria	4 °C
	Virus	—78 °C
Sputum	Mycobacteria	4 °C
Hair	Trace metals	Ambient

Following the collection and processing of samples, specific types of samples were either shipped immediately or held for one shipment of that type of sample. The samples that required immediate shipment were the throat swabs and feces for bacterial analysis and the sputum specimens. These samples were sent by air at the end of the sampling day. A Kool-Pac was placed in each insulated mailer to keep the samples cool until analysis.

Prior arrangements were made so the samples shipped from Chicago in the early morning hours (about 1 a.m.) would be picked up at the San Antonio airport upon arrival.

The frozen samples awaiting shipment were kept either in a freezer or in ice chests packed with dry ice. Approximately one week before the shipment of all the frozen samples, the airline's freight manager at O'Hare was contacted to reserve a specific flight. The samples were shipped in dry ice and could not occupy the same freight area on the plane with live animals.

The remaining samples such as the feces for parasite analysis and the hair samples were also in the shipment with the frozen samples but separate from them. The remaining supplies or equipment was sent back to the San Antonio labs via truck along with the equipment used for the environmental survey.

Procedural Changes—Prior to the last human sampling period, the procedure for collection of feces for parasite investigation was modified. During the previous sampling periods, feces specimens were collected at home by the subjects and brought to the collection center. The samples were then aliquoted to the various vials filled with media at the processing center as previously described. The change of the procedure involved a set of 50 subjects selected at random, living throughout the study area. They were given a cup to collect a feces specimen. A vial with the merthiolate was poured into a labeled vial with the iodine just prior to the subject sampling the feces specimen with the sterile sticks provided. A small amount of the feces was placed into the vial with the mixture. The contents of the vial were stirred until a homogeneous sample was obtained. The vial was capped and brought to the collection center at the time of their scheduled appointment. No further processing of the sample took place at the processing center other than to include these specimens with the other samples designated for parasitic analysis.

ANALYTICAL METHODS

Organizational Overview

Organizations responsible for various portions of this study are listed in Table 2 in Section 1 of this report. Each organization was selected because of its outstanding reputation in that area of endeavor. The responsibility for analysis of environmental aerosol and sewage samples was changed to UTSA during the last sampling periods due to their heavy involvement in programs of a similar nature for both EPA and the U.S. Army Research and Development Command.

Aqualabs was selected not only because of its good reputation, but because of its location close to the study area. In order to obtain reliable data it is necessary that certain analyses such as standard plate count, fecal coliform and total coliform be begun as soon as possible after collection. Aqualabs was able to meet our schedule which called for sample delivery after normal working hours.

Microbiological Analysis of Environmental Samples

Bacteriology—

Mixed Liquor Samples from Aeration Basin—The aeration basin samples were analyzed by procedures detailed in Standard Methods, either 13th edition(22) or 14th edition(23). Total and fecal coliform were determined using the membrane filter method(23), and standard plate count was determined according to Standard Methods(23) using an automatic colony counter.

Isolation of microorganisms was conducted by inoculating samples onto S-S Agar, Endo Agar, McConkey's Agar, and Blood Agar. Lowenstein-Jensen Medium and Middlebrook 7H-10 Medium were used for isolation for Mycobacterium species. Identification of microorganisms was by procedures and techniques as given in Manual of Clinical Microbiology[24], and Bacterial and Mycotic Infections of Man[25]. Cultural morphology, biochemical reactions, microscopic appearance, and serologic testing were employed as required.

Composite Samples–Analyses for fecal streptococci were performed in accordance with standard procedures and techniques that have been established for identification of these organisms in Standard Methods[23]. The membrane filter technique was employed as this procedure yields more reproducible results than does MPN.

Fluorescent pseudomonads (i.e., Pseudomonas aeruginosa, P. putida, and P. fluoresens) were determined by the following procedure. A direct and quantitative approach was found to be more useful for their enumeration than the MPN analysis, since fluorescent pseudomands were present in large numbers in the large-volume composite and aerosol samples. Samples were diluted and plated in triplicate onto previously solidified plates of King's medium B, commercially available as Pseudomonas Agar F (Difco), and onto plates of Centrimide Agar (Difco). The former medium is optimal for production of fluorescent pigments (pyroverdin) by pseudomonads and the latter is a selective medium for Pseudomonas. Following incubation at 37°C for 48 hours, the number of fluorescent pseudomonads was determined by noting the number of green fluorescing colonies observed with long-wave ultraviolet light in the dark. When the Pseudomonas Agar F plates were excessively crowded with other types of organisms, all colonies from appropriate dilutions were picked from the selective pseudomonad medium (Centrimide Agar) to sectors of Pseudomonas Agar F plates. Following incubation, the number of fluorescent colonies were confirmed by demonstrating that they were oxidase positive.

Enrichment for Salmonellae (including Arizona) was carried out following concentration of samples by filtration of measured volumes of sample (the volume filtrable depending on the level of organic and particulate matter) on diatomaceous earth plug and an unconcentrated 10-ml sample were enriched in separate bottles of selenite and tetra-thionate broths. After enrichment, aliquots were streaked for isolated colonies onto a moderately selective medium (XLD or Hektoen enteric agar) and a highly selective medium (SS). Identification of suspect colonies was accomplished by a biochemical screen (oxidase, Triple Sugar Iron, Motility, Indole, Ornithines, Lysine, Urea). Additional biochemical tests were performed on all colonies with a tentative identification of Salmonellae.

A qualitative procedure for the concentration and isolation of Shigella was carried out as described in Standard Methods[23]. Filtration through diatomaceous earth was used to concentrate a large proportion of all microorganisms present in a 1- to 2-liter sample. The resulting plug of diatomaceous earth was divided into equal portions for addition to bottles of GN broth (BBL). One-half of the same plug also was used for enrichment of Salmonella as described above. A 10-ml portion of the unconcentrated sample was added to a separate bottle of enrichment medium. After 24 hours enrichment at 37°C, aliquots from the bottles were plated for isolated colonies onto xylose lysine desoxycholate (XLD) agar. Although several enrichment-plating media combinations are available for isolation of Shigella, the GN-XLD combination repeatedly has been observed to be superior for recovery of the organism.

Proteus was determined by directly plating serial dilutions of the sample onto moderately selective and highly selective enteric media. All colonies were oxidase tested; on those which were negative, a preliminary biochemical screen was performed. All colonies tentatively identified as Proteus were subjected to further biochemical tests for confirmed identification.

Large Volume Microbial Characterization Samples–

Large volume samples were collected both at the beginning of the study and at the end. They were intended to provide information that would assist in examining the possible relationship which might exist between routine indicator organisms and selected pathogens.

A number of investigators have reported that staphylococci have a greater resistance to residual chlorine than do the coliforms and fecal streptococci. Staphylococci as an indicator of pollution in swimming pools may be primarily a measure of pollution arising from the bathers' eyes, ears, nose, and throat. However, staphylococci also are a component of the normal gut flora of man and many provide a useful measure of fecal pollution, particularly in treated waters. In early parts of the study, a quantitative membrane filter (MF) procedure described in Standard Methods(23) was employed. The sample size varied in order to yield MF counts within a desired 400-100 colony range on M-Staphylococcus broth-soaked absorbent pads. However, enumeration of yellow pigmented colonies and their subsequent confirmation as S. aureus was complicated by the heavy mixed growth on the filters. This procedure was abandoned and samples (0.1 ml) were plated in triplicate directly to previously solidified plates of Mannitol Salt agar. This change resulted in a marked reduction of "background" growth, but reduced the volume of sample that could be analyzed. Typical colonies showing a yellow zone of mannitol fermentation were fished for confirmation of identity by staining techniques and coagulase production.

Tubercle bacilli survive for long periods in feces, sewage, and water and have a greater resistance to chlorination than the coliform indicator group. Mycobacteria were assayed quantitatively by a procedure which almost totally suppresses sewage saprophytes while permitting recovery of most Mycobacteria. A large sample was treated for 20 minutes with 500 ppm of Benzalkonium chloride (Zephiran), diluted and plated to the surface of previously prepared plates of Middlebrook 7H10 Agar. Plates were incubated with five-percent CO_2 and examined over a period of one month for the appearance of colonies of Mycobacteria. Colonies that appeared were identified by examination of stained (Ziehl-Neelsen) smears for acid-fast bacilli and by other procedures as outlined in Figure 7.

Members of the genus Leptospira have been implicated in a variety of human diseases. Entry into the host generally occurs through abrasions of the skin or through mucosal surfaces following contact with water contaminated with urine of infected humans or wild and domesticated animals. Pathogenic leptospires may survive for months in neutral or slightly alkaline waters. "Saprophytic" or "water" leptospires (L. biflexa) are found predominately in fresh surface waters and are rarely associated with infection. The assay for leptospires was accomplished by their initial separation from contaminating microbes by passage of the test samples through 0.45μ membrane filters. Leptospires will pass through the filters because of their small diameters. The filtrate and unfiltered samples were diluted into tubes of Stuart's liquid medium (with 10- percent inactivated serum) containing 200 $\mu g/ml$ of 5-fluorouracil to inhibit the growth of contaminating microorganisms. The tubes were incubated in the dark at 28°C. Cultures were examined at 5- to 7-day intervals over a total period of six weeks for growth and microscopically (dark-ground microscopy) for the characteristic leptospiric morphology and motility.

Spores of the anaerobic Clostridium perfrigens (Cl. welchii) are very resistant to disinfectants and other detrimental environmental effects and survive longer in water than conventional indicator organisms and most pathogens. This organism was determined by the test recommended by the World Health Organization. Aliquots of decimal dilutions of the test samples were inoculated in triplicate into freshly boiled litmus skim milk medium (with 0.1% "reduced" iron powder).

The tubes were heated at 80°C for 15 minutes to destroy vegetative cells, incubated at 37°C and examined over a period of five days for positive "stormy fermentation" reactions. To decrease the incidence of false positive tubes, the tests were confirmed by examination of wet mounts and stained smears for nonmotile, encapsulated, Gram-positive rods. Spores, if present, were located centrally within the cells. Computation of the MPN index was accomplished by consulting probability tables used for estimation of coliforms.

As emphasized in Standard Methods(23), differentiation of the genus Klebsiella from other coliform organisms is important because of its association with human respiratory and genitourinary infections. Quantitation of Klebsiella in the highly mixed samples was complicated by the lack of an isolation procedure that is

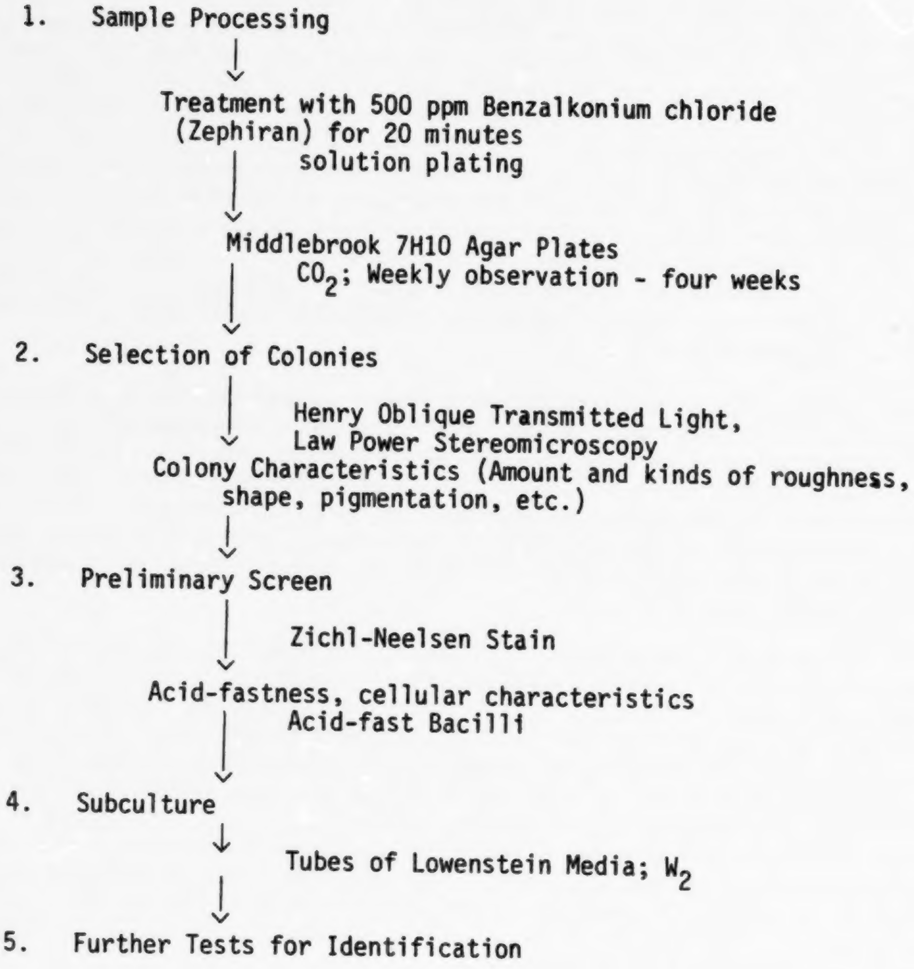

1. Sample Processing
Treatment with 500 ppm Benzalkonium chloride (Zephiran) for 20 minutes
solution plating
Middlebrook 7H10 Agar Plates
CO_2; Weekly observation - four weeks
2. Selection of Colonies
Henry Oblique Transmitted Light, Law Power Stereomicroscopy
Colony Characteristics (Amount and kinds of roughness, shape, pigmentation, etc.)
3. Preliminary Screen
Zichl-Neelsen Stain
Acid-fastness, cellular characteristics
Acid-fast Bacilli
4. Subculture
Tubes of Lowenstein Media; W_2
5. Further Tests for Identification

Figure 7. Schematic diagram of mycobacteria isolation.

highly differential or selective for these organisms. The capacity of Klebsiella and Enterobacter to fix nitrogen and thus to form large colonies on a nitrogen-deficient medium has been employed for the differential isolation of these organisms from feces. However, the most commonly employed ability of Klebsiella to produce large mucoid colonies on differential enteric media containing a high concentration of carbohydrate (e.g., EMB agar) was utilized in the present study.

The isolation and identification scheme employed for Klebsiella is summarized in Figure 8. Klebsiella ozaenae and the rare K. rhinoschleromatis were screened for in addition to the more common K. pneumoniae.

Most Klebsiella in nature are encapsulated and give rise to mucoid colonies, but rough forms also occur. Finally, the closely related genera Enterobacter and Serratia, that "classically" produce less mucoid colonies than Klebsiella, cannot be differentiated from the latter on the basis of colonial morphology alone.

The above considerations and the large number of mucoid colonies observed following plating of the samples to the nonselective enteric media, made it apparent that quantitation of Klebsiella would have to be carried out in an indirect manner. Individual mucoid colonies, randomly picked from composite and aerosol samples plated throughout this study to EMB, MacConkey, and ENDO agars, were tested for identification as Klebsiella. From this analysis, EMB was selected as the medium of choice for determination of total mucoid colonies.

Members of the other genera of Enterobacteriaceae (i.e., Enterobacter, Seratia, Edwardsiella, Escherichia, Citrobacter, Providencia and Yersinia) were determined by picking colonies from samples dilution plated to moderately selective (XLD and Hektoen) and highly selective (Bismuth Sulfite and SS) enteric plating media. Two-to-three representatives of every colony type observed under low-power microscopy with oblique transmitted lighting were subcultured for identification as illustrated in Figure 8.

All colony types picked for identification following enrichment for Salmonella and Shigella as described before also were characterized to the species level for inclusion in this aspect of the study. Colonies from the nonselective enteric plating media (EMB, ENDO and MacConkey) were not selected for this aspect of the study. Since the coliforms (particularly E. coli) constituted the major portion of Enterobacteriaceae on the nonselective media, their light-to-heavy suppression on the selective media was desirable to increase the chance of picking other types.

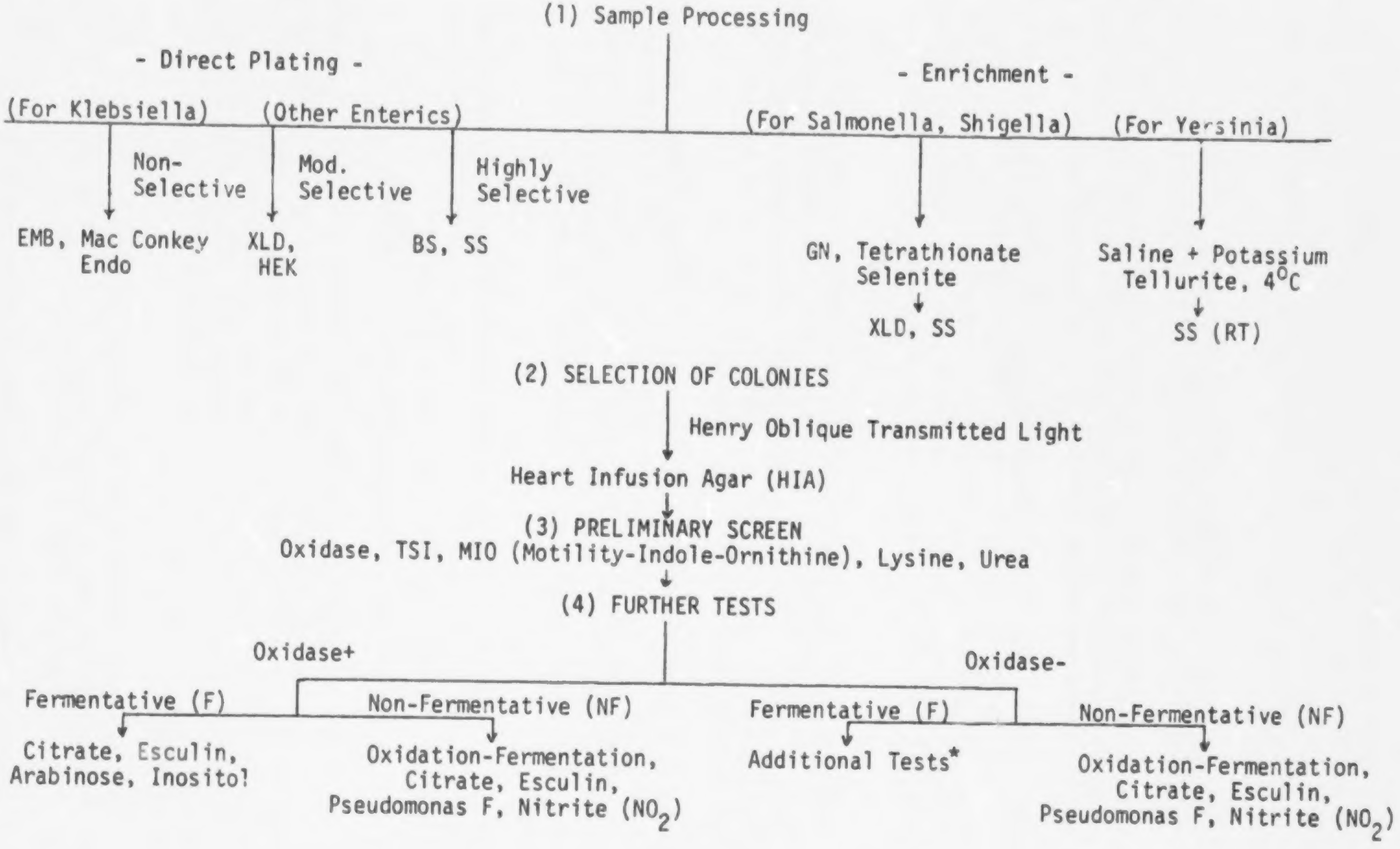
Yersenia enterocolitica was determined by selective enrichment of membrane filter-concentrated samples or diluted samples refrigerated in isotonic saline with 25 μg/ml of potassium tellurite and plated to SS agar. After incubation for two days at 25 °C, colonies were identified as described previously.

Assay for total and fecal coliform was conducted as prescribed in Standard Methods.

Aerosol samples--The procedures employed for isolation and identification of bacteria from aerosol samples in Periods 1, 2 and 4, whether the organisms were collected directly onto Blood Agar Plates, MacConkey's Agar Plates, S-S Agar Plates and Middlebrook 7H-10 Medium Plates or impinged and trapped in a fluid vehicle for transport to the laboratory, were standard laboratory procedures as referred to above. Bacterial counts were determined on the plates which had been shipped from Chicago, and suspicious colonies were picked for identification. Fluid samples were plated in the laboratory and isolates selected for identification by the techniques discussed previously in this Section.

The methods employed in bacterial analyses for Period 5 aerosol samples were identical to those employed in the analysis of effluent samples with the exception that the sample volumes were larger for the aerosol samples. Further, the direct spread plate technique was used for fecal streptococci.

Soil Samples--Bacteriological examination of soil samples, after the soil was suspended in water, was performed by procedures similar to those outlined previously in this Section.


(1) Sample Processing
- Direct Plating -
- Enrichment -
(For Klebsiella)
(Other Enterics)
(For Salmonella, Shigella)
(For Yersinia)
Non-Selective
Mod. Selective
Highly Selective
EMB, Mac Conkey Endo
XLD, HEK
BS, SS
GN, Tetrathionate Selenite
XLD, SS
Saline + Potassium Tellurite, 4°C
SS (RT)
(2) SELECTION OF COLONIES
Henry Oblique Transmitted Light
Heart Infusion Agar (HIA)
(3) PRELIMINARY SCREEN
Oxidase, TSI, MIO (Motility-Indole-Ornithine), Lysine, Urea
(4) FURTHER TESTS
Oxidase+
Oxidase-
Fermentative (F)
Non-Fermentative (NF)
Fermentative (F)
Non-Fermentative (NF)
Citrate, Esculin, Arabinose, Inositol
Oxidation-Fermentation, Citrate, Esculin, Pseudomonas F, Nitrite (NO2)
Additional Tests*
Oxidation-Fermentation, Citrate, Esculin, Pseudomonas F, Nitrite (NO2)

* Arabinose, adonitol, arginine dihydrolase, citrate, esculin, JTR (Jordans tartrate), KCN, malonate, MR, MP, mannitol, dulcitol, rhamnose, salacin, sorbitol, motility (wet-mount and/or semisolid agar), indole from tryptone broth, enterotube, salmonella antisera, shigella antisera.

Figure 8. Schematic diagram of enterics isolation.

Water Samples--The procedures employed for isolation and identification of bacteria from water samples were similar to the procedures outlined previously in this Section.

Virology--

Mixed Liquor Samples from Aeration Basin--The aeration basin samples from Period 4, received in one-half gallon bottles, were concentrated by the method described as the "sandwich" technique. Briefly, this consists of drawing the fluid sample through a sandwich of a mixture of Celite (Diotomaceous Silica) and Talc between two Tween-80- treated and distilled water-rinsed 42-mm prefilters. The concentrated virus is then eluted from the Celite-Talc sandwich by forcing through it 4-ml of 2 percent casein in 0.5 M Tris, pH 8.3. Isolation of viruses from the concentrates was performed by procedures given in Diagnostic Procedures, Viral and Rickettsial Infections(26), Viral and Rickettsial Infections of Man(27), and procedures of the NIH/WHO Regional Reference Center for Simian Viruses established at this institution. These procedures provide for demonstration of cytopathology in primary kidney cell monolayers and continuous cell cultures (WI-38) and detection of plaques by an agar overlay on cell monolayers in one-ounce prescription bottles.

Mixed liquor samples from Period 5 were separated so that the solid and liquid fractions could be assayed independently for both coliphage and enteroviruses. The samples were separated by low-speed centrifugation (5,000 × g) for five minutes. The liquid fraction was decanted and concentrated (see below) or used for direct plating. The pellet was resuspended in tryptose phosphate broth and homogenized in a tissue grinder prior to further centrifugation and assay.

All liquid samples were prepared for virus assay by the bentonite concentration method, which follows. Two-hundred mg of bentonite clay and 20 ml of 0.01m $CaCl_2$ were added to two liters of sample. The pH was adjusted to 6.0 and the sample mixed with magnetic stir bars for 30 minutes. The suspended solids were collected and pelleted by light centrifugation. The supernatant was discarded, the solids resuspended in tryptose phosphate broth, eluted for five minutes, and centrifuged again. The supernatant (approximately 10 ml) was decanted for assay. In the case of large volume samples, four liters were concentrated.

As a daily control, a known titer of Poliovirus Type I(CHAT) was added to 0.5 liter of the liquid fraction of the samples and concentrated. This procedure served to determine the concentration efficiency for that day's sample as well as cell sensitivity.

Viruses were enumerated routinely on Hela cell monolayers and reported as pfu/liter original sample (solid or liquid fraction).

Assays were carried out using 0.2-ml samples on Hela cell monolayers grown on 60-mm culture dishes in Eagle minimal essential medium plus 200 units of penicillin G per ml, 16.6 units of streptomycin per ml, 25 μg of gentamicin per ml, and 0.5 μg of Fungizone per ml.

Two-thirds of the plates of each assay were incubated three days and scored for plaques. To avoid overgrowth of slower growing enteric viruses by poliovirus plaques, the remaining one-third of each sample was mixed with pooled antipolio serum (types 1, 2, 3) diluted so that final antiserum concentration was 1:50. This level was shown experimentally to reduce stock virus titer by 95 percent or more. The virus concentrate-antipolio serum mixture was plated, incubated for five days, and stained to visualize plaques.

Incubation of all Hela cell monolayers was conducted at 37°C in a five-percent carbon dioxide-humidified atmosphere. After incubation, the monolayers were stained with two-percent neutral red in Hanks' balanced salt solution for two to three hours after which plaques were counted.

Coliphage samples were assayed using 18-hour E. coli K-13 as host organism; this was shown to be the most sensitive E. coli stain tested. Samples were prepared as described above. Results were reported as pfu/liter original sample (solid or liquid fraction).

Appropriate volumes (0.2, 0.3, or 0.5 ml) of the wastewater and 0.2 ml of host cells were added to 2.8 ml of liquified tryptose phosphate semi-solid agar (0.9 percent) and poured while warm (43°C) on 100-mm plastic petri dishes prepared with 20 ml of solidified tryptose phosphate agar (1.5 percent) base layer. When firm, the plates were inverted and incubated at 37°C for approximately eight hours prior to counting. For each sample fraction, a minimum of ten plates was used.

Aerosol Samples--The aerosol samples from Period 4 which had been collected by some form of impingement in fluids were concentrated and isolation of viruses performed by procedures described previously in this Section.

Due to the volume of aerosol collection fluid available for assay in Period 5 (25 ml), no concentration procedure was used. The entire volume was assayed as described above except that each 1.0 ml of sample was used to inoculate Hela monolayers on 100-mm plates. The sample was seeded on the Hela monolayers in the presence of 2X antibiotics. After 60 minutes for attachment, the inoculum was removed by aspiration and the infected monolayers rinsed twice with HBSS with 2X antibiotics prior to overlaying with agar. Approximately 50 percent of the plates were incubated for three days and scored; while the remaining number of plates were incubated for five days and scored.

Any areas of cytopathic effect (CPE) having characteristics of viral infection at three days and five days post-infection and not directly attributable to microbial contamination, were isolated using capillary pipettes. Hanks' balanced salt solution containing 1X antibiotics (Penicillin and Streptomycin, Gentamicin, and Fungizone) was added to each tube at 0.5 ml/tube. Such isolates were held at 4°C for at least 24 hours before infection of tube cultures.

Confluent monolayers of Hela cells grown in stationary tube cultures were infected with 0.2 ml of potential viral isolates. After an infection period of 1.5 hours during which time the inoculum was periodically redistributed over the cells, the inoculum was removed and 3 ml of prewarmed maintenance media containing 1X antibiotics was added. Infected cultures were returned to a 37°C CO_2 incubator.

Tubes were observed for CPE under 40X magnification on a daily basis over a period of five days. Any tubes showing destruction of the cell monolayer were harvested by three cycles of alternate freezing-thawing using a dry ice-ethanol bath and a 45°C water bath. Cellular debris was pelleted by low-speed centrifugation. Supernatants were collected (pH adjusted with $NaHCO_3$) and stored at 4°C. This procedure constituted first passage of isolates. Tubes which showed no CPE at five days were harvested as described and passed as "blind" isolates. Uninfected controls also were harvested and served as second passage controls.

Prior to infection of cells for second passage, all first passage supernatants were diluted approximately 1:2 with 1X HBSS and centrifuged at 15,000 × g (11,000 RPM) for 15 minutes. Supernatants from this "high-speed" centrifugation were transferred to sterile tubes and stored at 4°C.

Confluent monolayers of Hela cells were infected with first passage supernatants (0.2 ml/tube). After a 1.5-hour attachment period, the inoculum was removed and 3 ml of maintenance media containing 2X antibiotics were added. Infected cultures were returned to 37°C CO_2 incubator. Cultures were observed on a daily basis for CPE and handled as previously described. Any tubes harvested as positive from second passage were subjected to further verification by a three-day and five-day plaque assay. All isolates positive by this procedure were identified using the Lim-Benyesh-Melnick typing pool.

The total available volume of BHI + 0.1-percent Tween 80 (25 ml) was plated for coliphage in a manner similar to that described above. The only procedural change was that the 25 ml sample was distributed over twenty 100-mm plates.

Soil Samples--Virologic examination of the suspended soil samples was performed by procedures similar to those outlined for examination of aeration basin samples and also by direct examination without concentration other than centrifugation to precipitate the soil particles. The supernatant fluid was then inoculated directly onto the cell lines as above.

Water Samples--The procedures employed for isolation of viruses from water samples were similar to those outlined for examination of aeration basin samples above.

Trace Metal Analysis of Environmental Samples

General--

Instrumentation--All analyses were performed on either a Perkin-Elmer Model 503 Atomic Absorption Spectrophotometer (AAS) or a Perkin-Elmer Model 306 AAS. The Model 306 AAS is modified (Perkin-Elmer Modification Kit 040-0286) to reduce "stray light" from reaching the photomultiplier tube during operation of the flameless sampling devices.

Both AAS units are equipped with a Deuterium-arc background corrector which corrects for nonspecific absorption. The background corrector was routinely used on all analyses.

Absorption peaks were recorded on a Perkin-Elmer Model 056 Recorder with a 10-mv range.

Flameless analyses were performed with the following graphite tube furnaces: (1) a Perkin-Elmer HGA-2100 with the Model 503 AAS, (2) a Perkin-Elmer HGA-2000 with the Model 306 AAS, and (3) an Instrumentation Laboratory IL-455 with the Model 306 AAS. Flame analyses on both AAS units were by air-acetylene flames using a single-slot, 10-cm Burner Head (Perkin-Elmer Model 303-0418).

Calculation of analytical curves, regression analysis, and concentrations were performed on a Hewlett-Packard Programmable Calculator Model 9810A (H-P 9810A).

Mercury analyses were performed with a UV Monitor Model 1235 (Laboratory Data Control, River Beach, Florida).

Reagents--All reagents used for the preparation and analysis of the samples on this contract were of analytical grade or better.

Metal standard solutions (1000 ppm) were from Fisher Scientific (Houston, Texas) and Ventron Corporation (San Leandro, California).

Organic solvents decane and methyl isobutyl ketone (MIBK) were from Eastman Kodak (Rochester, New York).

The chelating reagent, ammonium pyrrolidinedithiocarbamate (APDC) was from Aldrich Chemical Company (Milwaukee, Wisconsin).

Triton X-100 surfactant was from J. T. Baker (Phillipsburg, New Jersey).

Contamination Control--A major problem in trace metal analysis is contamination of glassware, reagents, and samples with the metal(s) being analyzed. Minimizing this problem requires an extensive control program involving glassware cleaning, protection, and quality control measures.

All glassware and polyethylene containers that come in contact with samples or reagents are cleaned by the following procedure: Items are washed thoroughly with a laboratory detergent (Alconox, Inc., New York) in tap water. The clean glassware is rinsed with deionized water and placed in an acid vat containing HNO_3(1:1) and allowed to soak for 6 to 18 hours. Clean polyethylene containers are also placed in the acid vat but are removed after 4 to 6 hours. After acid soaking, the items are rinsed thoroughly with deionized water and placed in a drying oven until dry. The dry items are placed in a dust-free area and allowed to cool. Polyethylene containers are capped and sealed in polyethylene bags until ready for use. Glassware is returned to its proper container (see below) and stored in glassware cabinets until ready for use.

All glassware items are kept in polyethylene containers to minimize exposure to dust in the laboratory. Each container is numbered and contains one type of glassware (i.e. watchglasses, 5-ml volumetric flask, etc.). When all the glassware in a container has been used, it is returned to that container and carried through the washing procedure (see above) as a unit. While the glassware is being washed the container is also washed. Once the glassware has completed the wash cycle and dried, it is returned to the proper container. Several items (three to seven) of glassware are removed from the container at this time for quality control checks.

The number of each container of glassware going through the wash cycle is entered into a log book. Other information, such as name of technician performing washing procedure, type of glassware, length of acid-soaking, etc., is also recorded in this log book. This allows the glassware removed for quality control checks to be identified with a particular set of glassware being used in the laboratory. The glassware removed for quality control purposes is checked by rinsing with a known volume of 0.1N HNO_3 and comparing with the same acid that has not been used for rinsing. Normally one metal (Cd) is used for quality control checks but other metals may also be included if needed. The graphite furnace (AAS) is used for quality control analysis. Glassware which shows a significant difference between the used and unused rinsing acids metal content is referred back to the container number from which it came. That container is then returned to the washroom and the wash cycle repeated on all of its glassware.

Mixed Liquor Samples from Aeration Basin--

Digestion of the mixed liquor samples for Cd, Cu, Pb, and Zn analyses were based upon the digestion procedures recommended by EPA for total metal analysis of wastewater samples.

A 50-ml aliquot of the sample was pipetted into a 250-ml Vycor beaker and 20 ml of redistilled HNO_3 added. The beaker was placed on a hot plate (80 °C) and the sample evaporated to near dryness without letting it boil. Another 3 ml of HNO_3 was added to the sample residue and the beaker was again heated with a watchglass in place to create a gentle reflux condition within the beaker. From time to time small quantities of HNO_3 were added to maintain the volume. Refluxing of the sample continued until the sample was a light amber color (two to four hours). The watchglass was then removed and the sample allowed to evaporate to near dryness.

The residue was taken up in several ml of (1:1) HCl, warmed, and then filtered through a glass-fiber filler. The filtrate was collected in a 20-ml centrifuge tube and insoluble silicates were removed by centrifuging (2500 RPM) for 15 to 20 minutes. The supernatant was decanted into a 10-ml volumetric flask and the precipitate rinsed with several ml of (1:1) HCl. The rinsings were added to the volumetric flask and it was made to 10-ml with deionized water. This solution was used to analyze for Cd, Cu, Pb, and Zn as detailed later.

Preparation of the mixed liquor samples for Hg analysis was according to the recommended EPA method using the manual cold vapor technique(28).

A 100-ml aliquot of the sample was pipetted into a 300-ml BOD bottle and 5 ml of 0.5 NH_2SO_4 and 2.5 ml of 16N HNO_3 was added to digest the sample. Sufficient $KMnO_4$ (20%) solution was added to each sample to ensure a purple-colored solution. Complete oxidation of organic mercurials was accomplished by adding 8-ml K_2SO_4 (5%) solution and heating the samples in a water bath (95 °C) for two hours. The sample bottles were allowed to cool and 6 ml of NH_2OH. NaCl (12% v/w) solution was added to reduce the excess $KMnO_4$. The samples were then moved to the Hg analyzer where Hg concentrations were determined as described below.

Atomic absorption analyses of the mixed liquor sample digestates were performed according to the recommended EPA methods$^{(28)}$ and the AAS instrument manufacturers' procedures$^{(29)}$.

The mixed liquor samples were analyzed for Cd, Pb, and Hg. Both flame AAS and flameless AAS were used to determine the Cd and Pb concentrations while the cold-vapor AAS technique was used for Hg analysis.

Mixed liquor samples collected in February 1976 required the more sensitive flameless AAS technique because of the relatively low Cd and Pb concentrations present. The October 1976 samples were much higher in Cd and Pb and the flame AAS technique was required. Mercury also followed the same trend as Cd and Pb but the linear range of the cold-vapor AAS technique was sufficient to measure both sampling periods.

Cadmium analyses (flame) of the October 1976 samples required a 1:1 dilution with deionized water to bring the Cd concentration within the linear range of the instrument. Cadmium and Pb absorption were measured at 228.8 nm and 283.3 nm, respectively, for both flame and flameless AAS techniques.

Detection limit for Cd by the flame technique was 0.006 mg/ℓ and by the flameless was 0.0002 mg/ℓ. The detection limit for Pb by flame was 0.09 mg/ℓ and by the flameless technique was 0.003 mg/ℓ. Detection limit is defined as that concentration of analyte which will give a response 2X the standard deviation of a series of spiked samples which are detectable above the background noise.

Each mixed liquor sample was prepared and analyzed in duplicate for both Cd and Pb. The average relative standard deviation (RSD) for duplicate samples by the flame AAS technique was 3.8% for Cd and 13.5% for Pb. The average RSD for duplicates by the flameless AAS method was 40.6% for Cd and over 50% for Pb. The high RSD for Cd and Pb by the flameless method results from the very low concentrations of these analytes in the samples.

Recovery of Pb spiked mixed liquor samples ranged from 93% for flame AAS to 87% for flameless AAS. Recoveries of Cd spiked mixed liquor samples ranged from 89% for flame AAS to 120% for flameless AAS.

Mercury analyses of the digested mixed liquor samples were completed by adding 5 ml of 10% $SnCl_2$ solution to the BOD bottles and immediately connecting the bottle to the analytical train. The reduced Hg was swept into the absorption cell and the Hg absorption recorded at 253.7 nm.

The detection limit for Hg by this procedure was 0.0025 mg/ℓ and was limited only by the reagent blank Hg concentration.

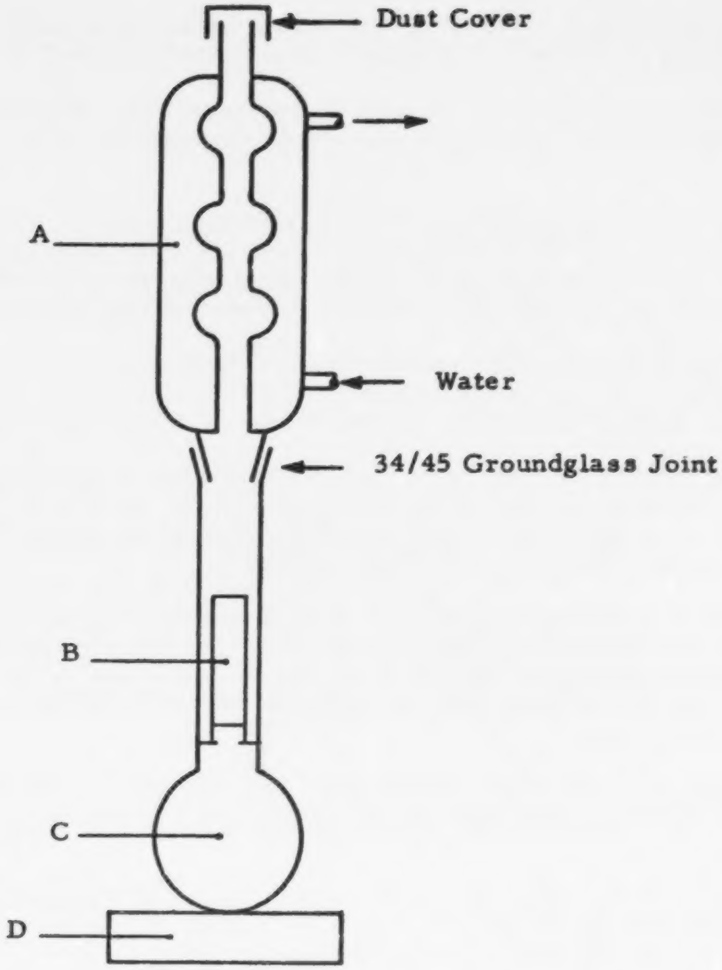
Recovery of Hg spiked samples averaged 103% and the average RSD for duplicates at the 0.47 mg/ℓ concentration level was 7.9%.

Particulate Air Samples--

Cadmium, Cu, Pb and Zn were determined in air particulate samples by the procedure of Thompson, Morgan, and Purdue$^{(30)}$.

The 20.3 × 25.4-cm glass-fiber filter was removed from its polyethylene bag and placed on a polyethylene sheet. A plexiglas template and stainless steel surgical knife were used to cut a 2.5 × 20.3-cm strip from the filter. The remainder of the filter was returned to its polyethylene bag.

The strip of filter removed was carefully cut into 1-cm lengths and placed into a 2.5 × 8.5-cm Pyrex extraction thimble using Teflon-coated forceps. Eighty milliliters of digestion acid (16 ml of redistilled HCl and 64 ml of redistilled HNO_3) was added to the specially constructed boiling flask (Figure 9) and the extraction thimble carefully lowered into its neck. The flask was then connected to the condenser unit and heat was ap-


Dust Cover
A
Water
34/45 Groundglass Joint
B
C
D

A	Ahlin-type condenser
B	Extraction vessel with coarse glass disk
C	Specially constructed boiling flask
D	Hot plate

Figure 9. Apparatus for the acid digestion of air samples.

plied. Once the acids began to reflux and wash over the filter strips, the temperature was adjusted such that a continuous refluxing occurred. Refluxing was continued for three hours before the heat was removed and the digestion acids allowed to cool. Several milliliters of 0.1N HNO_3 were poured through the top of the condenser and allowed to drain into the boiling flask.

The boiling flask was removed from the condenser unit and the extraction thimble removed. The boiling flask was placed on a hot plate (300°C) and a flow of N_2 added to assist in evaporating the digestion acids. Once the volume was reduced to several milliliters (never to dryness) the flask was removed from the hot plate, cooled, and quantitatively transferred to a graduated centrifuge tube (15-ml). The sample volume was made to 5.0 ml with deionized water before the sample was centrifuged for 30 minutes at 2000 RPM. A portion of the filtrate was decanted into a polyethylene vial (5-ml) taking care not to disturb the precipitate.

Cadmium analysis was done on this filtrate by aspirating into an air-acetylene flame (AAS). A 1-ml aliquot of this filtrate was pipetted into a 10-ml volumetric flask and made to volume with deionized water. This dilute (1:10) solution was used for Cu and Pb analysis using flame AAS.

The detection limit for each metal, based upon a 2000 m^3 air sample, was: Cd = 0.0003 $\mu g/m^3$, Cu = 0.004 $\mu g/m^3$, Pb = 0.045 $\mu g/m^3$, and Zn = 0.03 $\mu g/m^3$.

With each day's analysis, a series of spiked filter blanks was analyzed. The average recovery of these spikes for Cd (0.5 μg), Cu (5.0 μg), Pb (250 μg), and Zn (250 μg) was 100%, 91%, 96%, and 87%, respectively.

Mercury concentrations in the ambient air were measured by the charcoal absorption procedure of Scaringelli, Puzak, Bennet, and Denny(48). This procedure was used on all sampling periods except the last (October 1976). The amalgamation of Hg on silver wool by the procedure of Wroblewski, Spittler, and Harrison(31) was used for the last sampling period.

This change in the air-Hg methodology resulted from continuous problems which plagued the charcoal absorption procedure. These problems were (1) difficulties in cleaning the charcoal, and (2) contamination.

Each time the charcoal tubes were fired for cleaning or sample analysis, some unknown compound would bleed off the charcoal and mask the UV absorption of Hg at 253.7 nm. It would take several firings of each tube to reduce this signal to an acceptable level. But after several minutes, refiring of the tube would again give this masking signal.

Also the charcoal tubes would pick up Hg and/or some unknown compound from the atmosphere no matter what precautions were taken to protect the tubes.

The detection limit of Hg spiked on the charcoal tubes was 0.024 $\mu g/m^3$ based on an average air volume of 0.985 m^3. These parameters were determined under the best of conditions and have limited meaning in relationship to the actual samples collected and analyzed due to the problems mentioned earlier.

The amalgamation of Hg on silver wool proved to be a very convenient procedure for determining Hg-air concentrations.

The system used was that given by Wroblewski, Spittler and Harrison(31). The tubes containing the Ag-wool were fired to remove any traces of Hg absorbed on the Ag-wool. The tubes were immediately sealed for shipment to the sampling site.

Several of the tubes were shipped to the sampling site and returned unused as checks on contamination during shipment. None of these tubes gave a Hg signal when fired.

The detection limit for Hg with the Ag-wool system was 0.0018 µg/m^3 based upon an average volume of sampled air (0.2839 m^3). Recovery of Hg spikes added to the Ag-wool was 100%.

Soil Samples—

Soil samples were prepared and analyzed by a modification of the methods used by Smith and Windom(32) and Chester and Hughes(33) for sediment samples.

Several grams of the soil sample were dried overnight at 60 °C and the dried sample was then ground in a mortar and pestle. A 5-gram portion of the pulverized sample was weighed into a 250-ml Erlenmeyer flask and 50 ml of leaching solution [hydroxylamine hydrochloride:acetic acid (3:7)] added. The samples were then shaken overnight (15 hours) on a mechanical shaker. The solution was then filtered through a glass-fiber filter and the filtrate collected in a polyethylene bottle. All metals were determined by aspiration of this solution into an air-acetylene flame (AAS).

Detection limits for the metals were: Cd = 0.01 µg/g, Cu = 0.12 µg/g, Pb = 0.66 µg/g, and Zn = 1.8 µg/g.

Average recoveries were based on spiked soil samples carried through the leaching procedure. Cd (0.5 µg/g) = 96.8%; Cu (2 µg/g) = 91.7%; Pb (5 µg/g) = 91.8%; Zn (20 µg/g) = 106%.

Precision (RSD) based upon repetitive determinations (n = 6) of spiked samples was: Cd (0.20 µg/g) = 1.6%, Cu (0.83 µg/g) = 7.4%, Pb (22 µg/g) = 7.5%, Zn (8.4 µg/g) = 10.9%.

Mercury analysis of soil samples was from a modification of the recommended EPA procedure for Hg in sediments(28).

One gram of the dried and pulverized soil (described above) was weighed into a 2.5 × 13.0-cm digestion tube. Three milliliters of digestion acid $HClO_4$:HNO_3(5:1) and 1 ml of $KMnO_4$ (5%) were carefully added to the sample and it was gently shaken to mix the reagents. The sample was then placed into a water bath (75 °C) overnight (15 hours). After allowing the sample to cool, 1 ml of hydroxylamine hydrochloride (50%) solution was added to the sample and mixed. From this point the sample was analyzed by the conventional cold-vapor technique for Hg after adding $SnCl_2$ to reduce the Hg to its elemental state.

Quantitation for Hg was achieved by analyzing a series of standards prepared by this procedure and constructing an analytical graph (peak height vs concentration). The unknown samples were then quantitated from this analytical curve.

Detection limit for Hg using this procedure was 0.006 µg/g with an average recovery of 75%.

Precision, as RSD, for replicate (n = 7) determinations on a soil sample spiked at 0.04 µg/g was 7.5%. A sample spiked at 0.10 µg/g gave an average recovery of 85.3%.

Water Samples—

Water samples were prepared by the EPA method for total metals(28) and analyzed by the flameless AAS technique for Cd, Cu, and Pb. Zn was analyzed by the flame AAS method.

Detection limits for the elements were: Cd = 0.0007 mg/ℓ, Cu = 0.0032 mg/ℓ, Pb = 0.003 mg/ℓ, and Zn = 0.02 mg/ℓ.

Each metal was quantitated by spiking one of the water samples at three different concentration levels with the analyte metals and making an analytical curve (peak height vs. concentration) using the H-P 9810A. The other water samples were then quantitated for each particular metal using the appropriate analytical curve.

The RSD of five replicate samples spiked with each metal were: Cd (0.002 mg/ℓ) = 15.9%, Cu (0.009 mg/ℓ = 18.3%, Pb (0.009 mg/ℓ) = 14.8%, and Zn (0.08 mg/ℓ) = 13.6%.

Average recovery of spiked samples was: Cd = 101%, Cu = 97%, Pb = 92%, and Zn = 91%.

Water samples were analyzed for Hg by the recommended EPA method of manual cold-vapor AAS(28).

The detection limit was 0.00002 mg/ℓ and the RSD of four replicate samples at the 0.00006 mg/ℓ concentration level was 15.2%. Average recovery of Hg spiked (0.00005 mg/ℓ) water samples was 80%.

Microbiological Analysis of Clinical Specimens

Bacteriology--

Feces Samples--Bacteriological examinations of feces were performed in accordance with the standard procedures and techniques which have been established for isolation and identification of microorganisms by clinical diagnostic laboratories and by procedures standard for this laboratory. Techniques follow generally those described in the references cited above. Feces samples were inoculated onto S-S Agar, Endo Agar, Eosin Methylene Blue Agar, and MacConkey Agar Plates for primary isolation. Cultural morphology, biochemical reactions, microscopic appearance, and serologic testing were employed, as required.

Throat Swab Samples--Bacteriological examinations of throat swabs were performed in the same manner as the feces samples. Throat swabs were inoculated primarily onto Blood Agar Plates.

Sputum Specimens--Sputum Specimens were inoculated onto Loewenstein-Jensen Medium and Middlebrook 7H-10 Medium in screw cap tubes and incubated in a CO_2 incubator.

Virology--

Feces Samples--Isolation and identification of viruses from feces were performed by standard procedures(26) and by procedures of the NIH/WHO Regional Reference Center for Simian Viruses at SFRE. Monolayer cell cultures of primary baboon kidney and cultures of a continuous cell line (WI-38) were employed for demonstration of cytopathology.

Throat Swab Samples--Virologic examinations of throat swabs were performed by the methods used for feces and throat swabs. Primary isolation was performed on primary baboon kidney cells and WI-38 cell monolayers.

Viral Serology--Antibody studies for experience with viral agents were performed by methods given in the references above. The specific test system employed—hemagglutination-inhibition or serum neutralization—is designated on the respective tables.

Parasitology on Feces Samples--

Samples collected by the human subjects were processed at the field laboratory near the study area. This processing consisted of placing a small amount of feces in a 15-ml capacity screw cap vial containing 9 ml of merthiolate-formalin. One ml of iodine was added to this solution just prior to the feces samples.

Analysis of the samples took place at the San Antonio laboratories. The merthiolate-iodine-formalin concentration technique (MIFC) is that method originally proposed by Blagg, et al.(34). This simple technique consists of shaking the vial with NIF to insure a homogeneous solution. Two layers of gauze strain the solution as it is poured into a centrifuge tube. One to three ml of ether was added and the tube was vortexed for 10 seconds. The tube was then centrifuged at 2500 RPM for two minutes. The supernatant was discarded and the sediment was examined under medium- and high-power (100X) magnification. The results of the analysis are reported either as no parasites seen or, if any parasites are found, as identified.

Chemical Analysis of Human Tissue Samples

Trace Metal Analysis

Instrumentation—Instrumentation and reagents used for the trace metal determinations in human tissues were identical to those listed above.

Blood—Venous blood samples were analyzed for Cd and Pb by a modification of the atomic absorption methods of Hwang, Ullucci and Mokeler(34), Hauser, Himmer and Kent(35), and Mitchell, Ryan and Aldous(36).

A 2-ml aliquot of the thawed blood sample was pipetted into a 5-ml screw-cap extraction tube and 0.5 ml of Trisma buffer solution (pH 7.0) added. Next, 0.5 ml of a chelating-hemolyzing solution consisting of 2% (w/v) ammonium pyrrolidinedithiocarbamate (APDC) in a 2% (v/v) solution of Triton X-100 was added to the extraction tube. The tube was capped and vigorously shaken for several minutes then allowed to stand for 10 to 15 minutes to ensure complete hemolysis of the blood. To extract the Cd and Pb chelates, 0.5 ml of MIBK was added to the extraction tube and shaken for five minutes. The sample was then centrifuged to 2500 RPM for 10 minutes and the MIBK layer (top) removed to a 2-dram glass vial.

Cadmium and Pb determinations were made on this extract by pipetting 5- to 10-μl aliquots into the preprogrammed HGA-2000 graphite furnace and measuring the absorption at 228.8 nm (Cd) and 283.3 nm (Pb).

Quantitation of the blood extracts were by the "method of additions" using whole blood purchased from a local blood bank. These spiked blood standards were prepared and analyzed by the procedure outlined above. Analytical curves were prepared from these spiked blood standards using the H-P 9810A.

This procedure for blood-Pb analysis has been verified by participation in the Center for Disease Control's Blood-Pb Proficiency Testing Program.

Detection limits for blood-Cd and blood-Pb by this methodology are 0.014 μg/100 ml and 1.4 μg/100 ml, respectively.

The RSD for blood-Cd spiked at 0.12 μg/100 ml was 5.9% ($n = 6$) and for blood-Pb spiked at 7.6 μg/100 ml was 13.1% ($n = 6$).

Average recovery of spiked blood for Cd was 98.5%. Recovery of blood-Pb was based on CDC bovine blood samples and averaged 102.1%.

Copper and zinc in whole blood samples were determined by a modified Matousek and Steven(29) procedure.

A 100-μl aliquot of the thawed blood sample was pipetted into a 5-ml polyethylene vial. For Cu determinations, the blood aliquot was diluted 1:9 with deionized water and mixed well. Zinc determinations were made by diluting the blood aliquot 1:39 with deionized water and thoroughly mixing.

Both the Cu and Zn were determined by aspirating the diluted blood into an air-acetylene flame and measuring the absorption at 324.7 nm (Cu) and 213.9 nm (Zn).

The "method of additions" was used to quantitate both Cu and Zn. The procedure was the same as that described above for Cd and Pb. Detection limits for blood-Cu was 16.5 μg/100 ml and for blood-Zn was 34.6 μg/100 ml. A spiked blood sample containing 105 μg/100 ml Cu had an RSD of 8.6% ($n = 6$) and another sample containing 577 μg/100 ml Zn had an RSD of 2.2% ($n = 7$).

Average recoveries of spiked blood samples for Cu and Zn were 99.8% and 103.1%, respectively.

Blood-Hg determinations were by the cold-vapor method of Hatch and Ott(37) and Skare(38).

A 1-ml aliquot of the thawed whole blood was pipetted into a 2.5 × 13.0-cm digestion tube with a 24/40 ground glass joint. Three ml of $HClO_4$:HNO_3(5:1) was added and the blood was allowed to digest overnight in a water bath at 75 °C. After the samples had returned to room temperature, 3 ml of deionized water and 1 ml of hydroxylamine hydrochloride solution (50%) was added. The samples were mixed on a Vortex shaker. Next, 5 ml of 10% SnCl solution was pipetted into the digestion tube and it was immediately connected to the cold-vapor analytical train. The digestion tube was continuously shaken as the flow of N_2 bubbled through the sample and the released Hg vapor absorption was measured at 253.7 nm.

Quantitation of blood-Hg samples was by the "method of additions" as described for blood-Cd and Pb. The detection limits of blood-Hg by this procedure was 0.1 μg/100 ml and a spiked blood sample at 0.45 μg/100 ml had an RSD of 7.8% (n = 7).

Feces--Feces samples were prepared for Cd, Cu, Pb, and Zn analyses by the following methodology: A 1.5-gram aliquot of thoroughly mixed feces samples was weighed into a Teflon bomb(39). Five ml of concentrated HNO_3 was added and the bomb sealed. The bomb was placed on a hot plate (125-150 °C) for two hours to digest the feces and then allowed to cool to room temperature before opening. The digested feces solution was filtered through a glass-fiber filter and the filtrate collected in a 10-ml volumetric flask. Several milliliters of 0.1N HNO_3 was used to rinse the bomb and filter. Deionized water was used to fill the volumetric flask to 10 ml.

The method of Skare(38) was used to prepare the feces samples for Hg analysis. A 1-gram portion of the mixed feces sample was weighed into a 300-ml BOD bottle and 10 ml of concentrated H_2SO_4 and 2 ml of concentrated HNO_3 added. The bottles were protected from dust contamination and allowed to digest overnight. Next, between 15 and 45 ml of 30% $KMnO_4$ solution was added and the sample was placed on a steam bath for 30 to 90 minutes. Approximately 100 ml of deionized water was added followed by 6 ml of 12% hydroxylamine hydrochloride. The sample was ready for Hg analysis as described below.

The diluted feces digest solution (10 ml) was used for the determination of Cd, Cu, Pb, and Zn.

Cadmium and copper were determined by aspirating the digest solution directly into an air-acetylene flame and measuring the absorption at 228.8 nm (Cd) and 324.7 nm (Cu).

One milliliter of the 10-ml digest solution was diluted to 50 ml with deionized water and this diluted (1:500) digest was aspirated into an air-acetylene flame for Zn analysis at 213.9 nm.

Lead was analyzed by injecting 10-μl aliquots of the digested feces solution (10 ml) into a preprogrammed HGA-2000 graphite furnace and measuring the absorption at 283.3 nm.

Quantitation of Cd, Cu, Pb, and Zn was by making spiked standard solutions at the same acid concentration here as the digested samples and developing an analytical curve (concentration vs. peak height) with the H-P 9810A.

Detection limit for Cd and Cu in feces was 0.014 μg/g and 1.5 μg/g, respectively, based upon wet weights. The detection limits for Pb and Zn in feces were 0.10 μg/g and 7.3 μg/g(wet weight), respectively.

Recovery of analytes was determined from spiked feces samples carried through the preparation and analysis procedures. Cadmium recoveries averaged 94.3% while Cu recoveries averaged 95.6%. Recoveries of Pb and Zn averaged 104.2% and 99.0%, respectively.

Feces samples spiked at 0.15 μg/g Cd, and 11.5 μg/g Cu had RSD of 15.7% (n = 11) and 9.3% (n = 5), respectively. While feces spiked with Pb at 0.64 μg/g had an RSD of 23.4% (n = 5) and spiked with Zn at 77 μg/g had an RSD of 1.4% (n = 3).

Hair--Preparation of the hair samples for trace metal analyses was patterned after the methods of Hammer, et al.(40) and Harrison, et al.(41)

Hair samples as received were cut into approximate 1-cm lengths using stainless steel surgical scissors. The cut hair was collected on a clean polyethylene sheet and transferred to a 250-ml Erlenmeyer flask. Then 200 ml of sodium laural sulfate solution (0.04% w/v) was added and the flask was placed on a rotating shaker for one hour. The surfactant solution was decanted off and the hair rinsed twice with 200 ml of deionized water. Both rinses were also decanted off. A third 200-ml portion of deionized water was added to suspend the hair sample and immediately poured into a 150-ml glass-fritted filter (coarse). The water was removed under vacuum filtration and another deionized water rinse followed.

After removal of this last rinse, 100 ml of isopropyl alcohol was added to the sample and it was allowed to soak for approximately five minutes with occasional stirring. The alcohol wash was removed by vacuum filtering and the hair was again rinsed twice with deionized water.

Once most of the water had been removed, the hair sample was transferred to a 150-ml polyethylene beaker and covered with a piece of loose-woven paper to prevent dust contamination. The beaker was then placed in a drying oven (110 °C) for one to two hours. The beaker was removed from the oven and the washed and dried hair was ready for digestion.

A 1-g portion of the washed and dried hair sample was weighed into a 250-ml Vycor beaker using Teflon-coated forceps to transfer the hair. Digestion of the hair was accomplished by adding 10 ml of HNO_3:$HClO_4$(1:1) to the sample and allowing it to stand overnight. The sample was then placed on a hot plate (200 °C) and a flow of N_2 added to reduce the volume. This operation was performed in a stainless steel hood. The sample volume was reduced to 1 to 2 ml or until dense white fumes were given off. Under no circumstances was the sample allowed to go to dryness during this step.

The beaker was removed from the hot plate and allowed to cool before quantitatively transferring the remaining digest solution to a 10-ml volumetric flask. Rinsing off the digestion beaker and filling of the volumetric flask to 10 ml was done with 1N HNO_3. The diluted hair digest was then placed in a polyethylene bottle and stored under refrigeration (4 °C) until analyzed.

The diluted hair digest was allowed to reach room temperature before aspirating into an air-acetylene flame for Cd, Cu, Pb, and Zn analyses. Cadmium absorption was measured at 228.8 nm, Cu at 324.7 nm, Pb at 283.3 nm, and Zn at 213.9 nm.

A composite hair sample was made from a large quantity of hair obtained from a local barber shop. This composite hair sample was washed according to the method above and spiked with all metals being determined prior to digesting. These spiked, composite hair samples were analyzed daily to quantitate the hair samples (method of additions). Calculation of analytical curves from peak heights vs. concentration were performed on the H-P 9810A as described earlier.

Detection limits were: for Cd in hair 0.13 μg/g; for Cu 1.35 μg/g; for Pb 0.87 μg/g; and for Zn 15.1 μg/g.

Spiked composite hair at 0.90 μg/g Cd gave an RSD of 8.9% (n = 21). Hair spiked at 19.4 μg/g Cu gave an RSD of 9.2% (n = 4) while at 14.0 μg/g Pb gave an RSD of 15.1% (n = 17). Hair spiked with Zn at 164 μg/g had an RSD of 2.2% (n = 5).

Recoveries of spiked composite hair samples were: Cd = 97.3%, Cu = 106.5%, Pb = 83.0%, and Zn = 101.5%.

Concentration of Hg in hair was determined in the following manner. A 0.1-g portion of the washed and dried hair was weighed into a 2.5 × 13.0-cm digestion tube with a 24/40 ground glass joint. Five ml of $HClO_4:HNO_3(5:1)$ was added. The $HClO_4$ was ultrapure grade. Next, a 1-ml aliquot of 5% $KMnO_4$ solution was added and the digestion tube was placed in a water bath (75°C) for 15 to 20 minutes. This operation was performed in a stainless steel fume hood. After the sample was removed from the water bath, 10 ml of deionized water and 1 ml of hydroxylamine hydrochloride solution (50%) was added. The sample was thoroughly mixed and 5 ml of a 10% $SnCl_2$ solution added. The digestion tube was immediately connected to the cold-vapor analytical train. The Hg° vapor released from the sample was swept into the absorption cell and Hg absorption was measured at 253.7 nm.

Mercury in hair was quantitated by processing a series of aqueous spiked standards along with the unknown hair samples. Analytical curves were plotted with the H-P 9810A using peak height vs. concentration of the aqueous spiked standards.

Using this procedure and 0.1g of hair, the detection limit for Hg in hair was 0.17 μg/gm of dry hair.

Average recovery of Hg-spiked hair samples was 79.3% and a spiked sample at 0.35 μg/g gave an RSD of 9.1% (n = 7).

Urine--Determination of Cd, Cu, and Pb in urine was patterned after the extraction procedure of Kubasik and Volosin(42) and Parker, Humoller and Mahler(43).

A 10-ml aliquot of acidified urine was pipetted into a 10-ml screw-cap extraction tube and its pH adjusted to 7.0 with concentrated NH_4OH. One ml of Trisma Buffer (pH 7.0, 0.5M) solution was added. The sample was capped and vigorously shaken for one minute to thoroughly mix the reagents. Following this shaking, the pH of the sample was rechecked.

A 1-ml portion of a 2% (v/v) Triton X-100 solution containing 2% (w/v) APDC was added to the buffered urine sample and the sample was thoroughly mixed. Extraction of the chelated metals was accomplished by adding 1 ml of MIBK (water saturated) and vigorously shaking the sample for one minute. Centrifuging at 2500 RPM for 10 minutes separated the aqueous and MIBK layers and the latter was removed to a small glass vial for AAS analysis.

Cadmium, Cu, and Pb determinations were immediately performed on this urine extract using the HGA-2000 graphite furnace. Cadmium was determined at 228.8 nm, Cu at 324.7 nm, and Pb at 283.3 nm.

A composite urine sample was collected in our laboratories and spiked with each of the analyte metals at three different concentration levels. This composite urine was used to quantitate the unknown urine samples by the "method of additions." Peak height vs. concentration regression curves (analytical curves) were calculated for each of the three metals using the H-P 9810A calculator. The unknown urine samples' metal concentrations were determined from these curves.

A Cd spiked urine sample at 0.234 μg/ℓ had an RSD of 12.9% (n = 6) while Cu-spiked urine at 4.3 μg/ℓ had an RSD of 16.8% (n = 9). Lead-spiked urine at 7.8 μg/ℓ had an RSD of 16.0% (n = 8).

Recoveries of Cd, Cu, and Pb averaged 101.8%, 108.8%, and 107.7%, respectively, based on spiked urine samples.

Zinc determinations in urine were based on the (43) method of Parker, Humoller and Mahler.

An aliquot of the acidified urine was diluted 1:1 with deionized water and aspirated directly into an air-acetylene flame. Because of the nature of the diluted urine sample, a high-solids burner head was used for this analysis. Zinc absorption was measured at 213.9 nm.

Quantitation of urine-Zn was the same as described above for Cd, Cu, and Pb. An Zn-spiked urine sample at 340 $\mu g/\ell$ had an RSD of 3.9% (n = 4) and a recovery of 100.9%.

The method of Skare(38) was used to measure urine-Hg levels.

A 1-ml aliquot of urine sample was pipetted into a 2.5 × 13.0-cm digestion tube with a 24/40 ground glass joint and 0.2 ml of concentrated H_2SO_4 added. The samples were placed in a water bath to cool and allowed to stand approximately 10 minutes with occasional mixing. Next, a 2-ml portion of 6% $KMnO_4$ solution was carefully added and mixed. The digestion tube was protected from dust contamination and allowed to stand overnight at room temperature.

The following day, the excess $KMnO_4$ was reduced by adding 0.3 ml of hydroxylamine hydrochloride solution (20%). The sample was then removed to the Hg analyzer and 5 ml of 10% $SnCl_2$ solution added. The digestion tube was immediately connected to the cold-vapor analytical train and Hg absorption was measured at 213.9 nm.

A few of the urine samples had heavy precipitates when received for analysis. These samples were thoroughly mixed and a 10-ml aliquot removed for Hg analysis. The same procedure outlined above was followed only 10X more reagent volumes were used.

Quantitation of urine-Hg was by processing aqueous spiked standards along with the samples and calculating an analytical curve (peak height vs concentration) with the H-P 9810A calculator. Concentration of unknown urine samples was determined from this curve.

Detection limit for urine-Hg by this procedure was 1.14 $\mu g/\ell$ with a recovery of 102.5% based on spiked urine samples. A urine sample spiked at 7.83 $\mu g/\ell$ Hg had an RSD of 7.3% (n = 7).

Hematocrit Value of Blood Samples–

Hematocrits were determined on the blood samples at the time of collection. A Clay-Adams hematocrit centrifuge was used to spin the collected capillary blood tubes and the hematocrit value was read directly from the calibration graph on the centrifuge.

DATA FLOW AND PROCESSING

Identification and Integrity of Sample Data

The data utilized in this study came from a variety of sources: environmental samples from the vicinity of the sewage treatment plant, household health surveys of residents within 5 kilometers of the plant, and human subjects from these households who volunteered to participate in the study. The human subjects periodically provided various clinical specimens and health questionnaire information, as depicted in Table 1 in Section 1.

To develop valid findings from this multitude of sample analysis and questionnaire data, it is essential that the identity and integrity of the data be preserved. Accordingly, an integrated data system involving a unique sample code, computer-generated sample labels, keypunched questionnaire forms, and analytical data reporting forms was implemented. This system insured that each sample was uniquely identified (participant ID or sample location, medium, analysis, sampling period) and that this identity was transmitted with the analytical values from sample collection through processing, storage, preparation, analysis, reporting, and statistical analysis.

We found that unique sample identification could be readily obtained by developing unique identifiers for the various aspects of a sample: the participant or location sampled, the medium sampled, the type of analysis to be performed, the sampling period, and necessary subsampling information. Distinct codes were assigned to each aspect. Volunteers were assigned consecutive numbers so that each selected participant had a unique ID number. Unique identifiers were also devised for each sample medium (air, soil, water, feces, blood, throat swab, etc.), each type of sample analysis (bacteria, viruses, trace metals, etc.), each sampling period, each sample location (for the environmental samples), and for each subsample. These identifiers were combined as a unique 15 digit code giving the history, contents, and planned analysis of each sample, and distinguishing this study's samples from those of other concurrent epidemiological studies. The composition and interpretation of this sample code is given in Table 7 . A typical sample code is 0478TBCH2--4007. This code identifies the throat swab (T) for participant 478 from sampling Period 2 at Chicago (CH) on this study (4007); it is to be analyzed for bacteria (B).

Sample Labels

Sample labels were used to affix the sample code to every bottle containing the sample or a portion of the sample. Appearing on the sample label were both the sample code (in the lower left hand corner) and several printed words. The printed words gave enough information to the field personnel to properly process and distribute the sample without needing to interpret the sample code. Thus the sample labels facilitated correct sample processing and distribution while preserving the sample's identity. Typical sample labels are given in Figure 10 . The last sample label in Figure 10 , for example, would be placed on the bottle containing the portion of the BHI fluid from the air sample obtained by high volume sampler 1 on run 20 during Period 5 that is to be analyzed for enteroviruses (VIRUS) by the UTSA laboratory.

Special computer programs were written to generate the proper types and numbers of sample labels. The programs also sorted the labels so that they were printed in the sequence that was most convenient for their application to the proper sample containers before and during sample collection and processing in the field. For some sample media, the collected sample had to be split into several portions at the on-site field laboratory, because several analyses, requiring either differing preservatives or different laboratories, were to be performed. The proper number and type of processing labels were also generated for the bottles containing these processed sample portions. The collection sample labels contained both the participant's name and his identification number to minimize mistakes during sample collection. However, the processing sample labels contained only the identification number to maintain confidentiality.

Data Forms and Reporting System

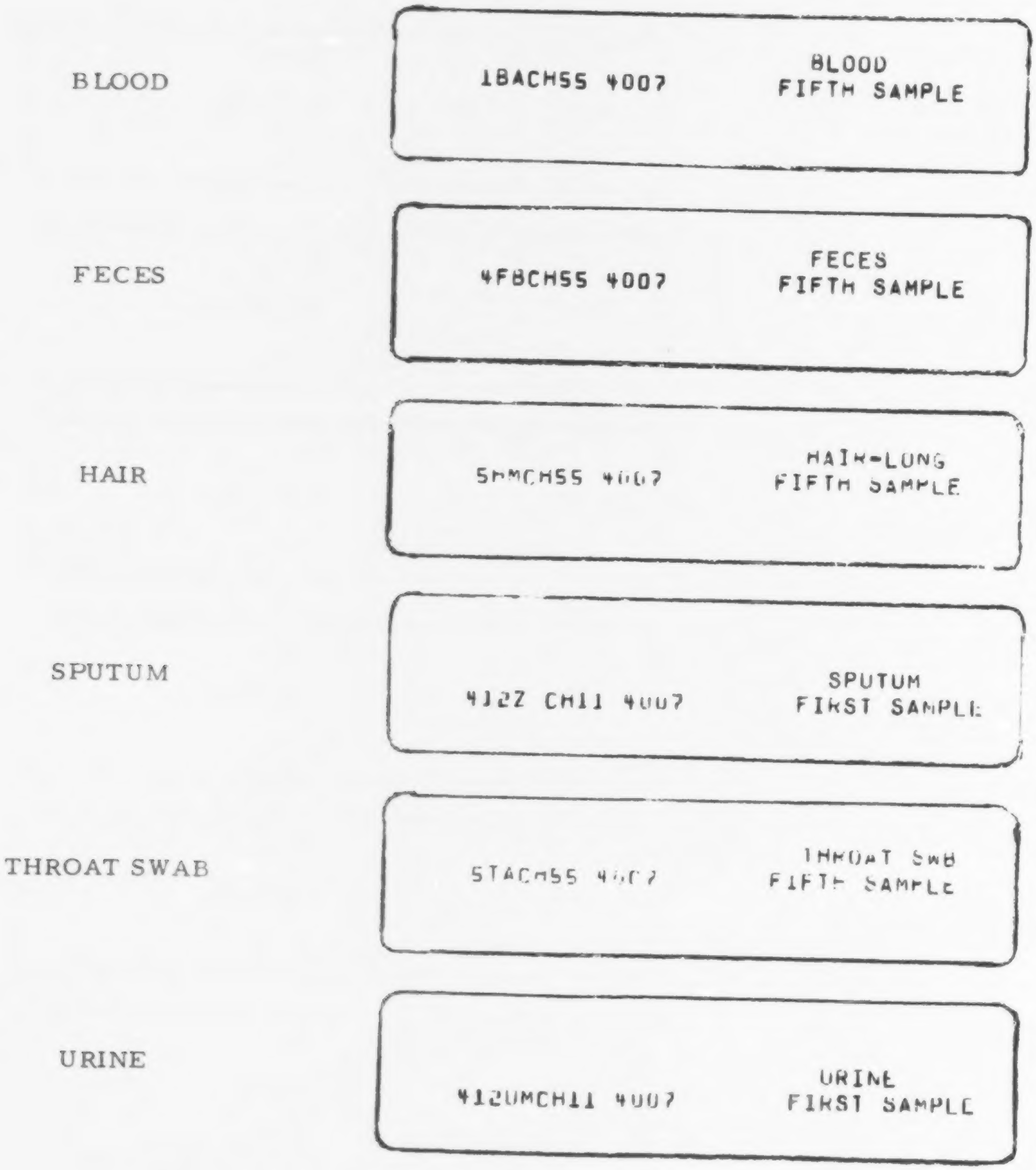
An efficient data reporting system was developed. The questionnaires for the household health survey, for participant recruitment, and for current health status were designed for direct keypunching after minimal coding during a manual scan. Special forms for reporting field and laboratory data were developed in collaboration with the field and laboratory supervisors for direct coding in a suitable data entry format. Coded examples of the following data forms are presented in Appendix G.

- Aerosol Run Report on Meteorology and Sampling
- Configuration
- UTSA-CART Aerosol Run Analysis Report
- Household Health Survey
- Health Survey Participant Questionnaire
- Current Health Status Questionnaire
- Metal Analysis Coding Form
- Pathogen Analysis Coding Form
- Pathogen Analysis Data Form

As these coded examples illustrate, each laboratory result is identified by including the relevant parts of the

TABLE 7. THE FIFTEEN-DIGIT SAMPLE CODE

Columns	Variable	Codes
1-4	Participant or location identification:	
	• For clinical specimens: participant ID number	0001 - 0654
	• For environmental samples: location	
	- Soil	S001 - S050
	- Water	W001 - W010
	- Aeration basin mixed liquor	R001 - R010
	- Air	UOUT, U-IN, 50, 500, 1600, 5000
	- High volume microbiological air	
	. Sampler number (Col. 1, 2)	01 - 12
	. Run number (Col. 3, 4)	01 - 20
5	Sample medium	A - Air B - Blood F - Feces H - Hair (long) I - Hair (short) R - Aeration basin S - Soil T - Throat swab U - Urine W - Water Z - Sputum
6	Sample analysis	A - Antibodies B - Bacteria C - Coliphage H - Mercury M - Trace metals P - Parasites V - Viruses (blank) - Several analyses
7-8	Sampling site	CH - Chicago
9	Sampling period	1 - 5
10-11	Detailed time or location	Miscellaneous numerical
12-15	Project number	4007



BLOOD	1BACH55 4007	BLOOD FIFTH SAMPLE
FECES	4FBCH55 4007	FECES FIFTH SAMPLE
HAIR	5HMCH55 4007	HAIR-LONG FIFTH SAMPLE
SPUTUM	412Z CH11 4007	SPUTUM FIRST SAMPLE
THROAT SWAB	5TACH55 4007	THROAT SWB FIFTH SAMPLE
URINE	412UMCH11 4007	URINE FIRST SAMPLE

Figure 10. Typical sample labels.

SEWAGE
BACTERIA

```
SAMPLER  2          SEWAGE
RUN        1        BACTERIA
 2 1SBCHS   24007   AQUA
```

SEWAGE
COLIPHAGE

```
SAMPLER  1          SEWAGE
RUN       10        COLIPHAGE
 110SCCHS  14007   UTSA
```

AIR
BACTERIA

```
SAMPLER  2          AIR
RUN        3        BACTERIA
 2 3ABCHS   14007   AQUA
```

AIR
MERCURY

```
SAMPLER  6          AIR
RUN        1        MERCURY
 6 1AMCHS   44007   SWRI
```

AIR
TRACE METALS

```
SAMPLER  2          AIR
RUN        1        METALS
 2 1AMCHS   14007   SWRI
```

AIR
VIRUS

```
SAMPLER  8          AIR
RUN       10        VIRUS
 810AVCHS  14007   UTSA
```

Figure 10. Typical sample labels (continued).

sample code on the laboratory data form. When the entire set of data forms for a sampling period were completed, the laboratory or field supervisor transmitted them as a package for data processing to avoid problems with incomplete data sets.

Participant and Household Survey Data Bases

The data reporting system was designed to permit construction of an automated participant data base by utilizing the natural structure of this data. The records to comprise the data base were the participant questionnaire data, precise residential distance and direction information, the pathogen isolations and antibody titers from the pathogen analysis coding form, the trace metal concentrations from the metal analysis coding form, and the current health status questionnaire data. The records in this participant data base were to be sorted primarily by participant ID, which appears in columns 1-4 of every record, secondarily by record type, and thirdly by sampling period within record type. Statistical analyses would be performed by abstracting the pertinent data from the data base. However, upon receipt of data sets from the early sampling periods, it became evident that construction of the data base was not warranted. Because of the lags in reporting some laboratory results, construction of the data base after receipt of all laboratory data would have delayed the statistical analysis much beyond an acceptable project schedule. Furthermore, because of the limited nature of the plant effect evident in the preliminary data inspection, many of the statistical analyses requiring an encompassing data base were found to be unnecessary. In fact, many of the statistical analyses could be performed manually on the properly compared data. Consequently, a more limited participant data processing approach tailored to the specific statistical analyses was implemented. The Pathogen Analysis Data Form, which tabulates the laboratory results in the paired comparison form needed for the statistical analysis, typifies the more limited ad hoc approach used for the participant data.

A household health survey data base was constructed because of the massive amount of questionnaire data. The records in the household health survey data base were the eleven card images keypunched per questionnaire for each of more than 2200 households surveyed. This data base was sorted primarily by household number (col. 1-4, with col. 1-2 identifying the sector and year) and secondarily by card number (col. 80). The household health survey data base was stored on magnetic tape in 80 column card image form.

Computational Techniques

The automated computational techniques which were used to analyze the extensive data generated during this project were chosen as being the most appropriate from numerous options that were available. SwRI currently maintains a special lease arrangement with the McDonnell Douglas (McAuto) computer facility in Huntington Beach, California for use of their CDC Cyber 70/74 equipment. This system is accessed through a CDC remote batch terminal at the Institute's Computer Laboratory. In addition, a Hewlett Packard 9810A programmable calculator with a limited package of statistical routines was utilized when the desired analysis was less involved and the quantity of data was sufficiently small to permit direct keyboard entry. The major automated computational procedures used in this project are listed in Table 8.

The major computer programs written for this project were those to generate sample labels and those to analyze the household health survey data base. The function of the sample label program is discussed previously in this section. The programs HHSTAB, HHSURV, and TESTX2 read the household health survey data base, tabulate the distributions of characteristics among households and the distributions of illnesses, diseases, and symptoms among household member categories, and compute the survey analysis test statistics.

GENERAL STATISTICAL METHODOLOGY

The specific research questions given in Section 1 have been addressed by applying suitable statistical methods to the study data to make appropriate inferences (i.e., findings). The general statistical analysis

TABLE 8. AUTOMATED COMPUTING PROCEDURES

Program	Source	Type	Computer System	Usage
MAILLB	SwRI	New	Cyber 74	Prints labels with names and addresses of human subjects
LABELS	SwRI	New	Cyber 74	Prints human subject, soil, and water sample labels
WRTLBLS	SwRI	New	Cyber 74	Prints air and aeration basin sample labels
PSTAT1	SwRI	Existing	HP9810A	Mean, standard deviation, coefficient of variation
DSTAT3	SwRI	New	HP9810A	Calculate arithmetic and geometric means, standard deviation for grouped data
DSTAT4	SwRI	New	HP9810A	Calculate pooled arithmetic and geometric means, standard deviation for several groups of data
ANOVA	HP	Package	HP9810A	Analysis of variance; one-way and two-way without interaction
CHISQ	HP	Package	HP9810A	2 x k chi-square
BMDO1D	BMD	Package	Cyber 74	Mean, standard deviation, standard error, with transgeneration
BMDO4D	BMD	Package	Cyber 74	Single character distribution
BMDO9S	BMD	Package	Cyber 74	Transformation and generation from data deck
BMDO8V	BMD	Package	Cyber 74	General ANOVA model
PRESTO	SwRI	Existing	Cyber 74	Stepwise multiple linear regression
HHSTAB	SwRI	New	Cyber 74	Distribution of household and human subject characteristics by incidence of symptoms and diseases
HHSURV	SwRI	New	Cyber 74	Distribution of household and human subject data by multiple cross-classifications
TESTX2	SwRI	New	Cyber 74	Calculate chi-square statistic

methodology employed is depicted in Figure 11 . Each research question has been translated into an appropriate hypothesis testing framework, and pertinent statistical methods have been identified to test the null hypothesis against the alternative. The validity of each potential method's assumptions has been evaluated by considering the nature of the data to be analyzed in order to select the optimal statistical method. The data have then been analyzed by the selected method to draw inferences relevant to the research questions. In those cases where the primary hypothesis testing produced an outcome with possible health hazard implications, a secondary hypothesis was also tested to fully satisfy the research question. In the environmental monitoring, for example, if the primary analysis indicated the sewage treatment plant was a significant source of a hazardous agent, a secondary analysis was conducted to determine whether the downwind residential levels of the hazardous agent were also elevated.

The particular statistical methodology utilized in each study area is presented in the applicable part of Section 6, Results. As Figure 11 indicates, each of these statistical methodologies share many common characteristics. The following paragraphs present the common elements for each step displayed in Figure 11 . The discussion includes general rules which have been employed throughout the statistical analyses, with the exceptions noted in Section 6 for particular analyses.

Sensitive variables and suitable hypotheses have been formulated for each research question, taking the experimental design of the study area into account. The appropriate variables and hypothesis for a research question depend upon the nature of sewage treatment plant exposure which might be measured in the various types of sampling conducted.

Most of the sampling, including the health survey questions, the clinical specimens for microbiological and trace metal analyses, and the soil and water environmental monitoring, might detect the accumulated effects of relatively long-term exposure to the sewage treatment plant. For these cumulative exposure measures, the appropriate variable and hypotheses involve comparing the difference in the levels of the exposure measure between the operational sampling period and the baseline sampling period at the same time of year. If the sewage treatment plant does have detrimental health effects, one would anticipate an increase in levels in the operational period, especially very close to the sewage treatment plant. Our general statistical methodology in such study areas has been to test the null hypothesis of no difference between the operational and baseline levels against the two-sided alternatives of either a significant increase or a significant decrease. Since there are many possible reasons for an operational period increase that are unrelated to sewage treatment, variables having a significant operational period increase have been further examined to ascertain whether the increased levels are related to exposure to (usually, distance from) the sewage treatment plant.

The air sampling, on the other hand, detects very recent and brief exposure to the sewage treatment plant. The proper variables and hypotheses for air sampling compare downwind levels with upwind levels for operational period sampling runs. The null hypothesis of no difference is tested against two-sided alternatives of a significant downwind increase or decrease. The closest downwind levels are compared against the upwind levels to determine whether the sewage treatment plant is a significant source of the measured hazardous agent. When the plant is a significant source, the residential downwind and upwind levels have been compared to see if the plant remains a significant source in residential areas.

The appropriate general approach has been utilized to formulate each research question in a statistical hypothesis testing framework. Two-sided tests of the null hypothesis have been employed to insure objectivity and to be conservative in the identification of possible sewage treatment plant health effects. While a 5% significance level has been used in the hypothesis testing, interpretation is based largely on the P value of the test statistic. Thus test results in the $.05 < P < .10$ range are considered borderline significant, while results of $P < .01$ are interpreted to be very significant. Potential statistical methods have been identified to conduct each hypothesis test. In most cases, several applicable techniques were found, including a parametric method under one or more data transformations and its non-parametric analogue.

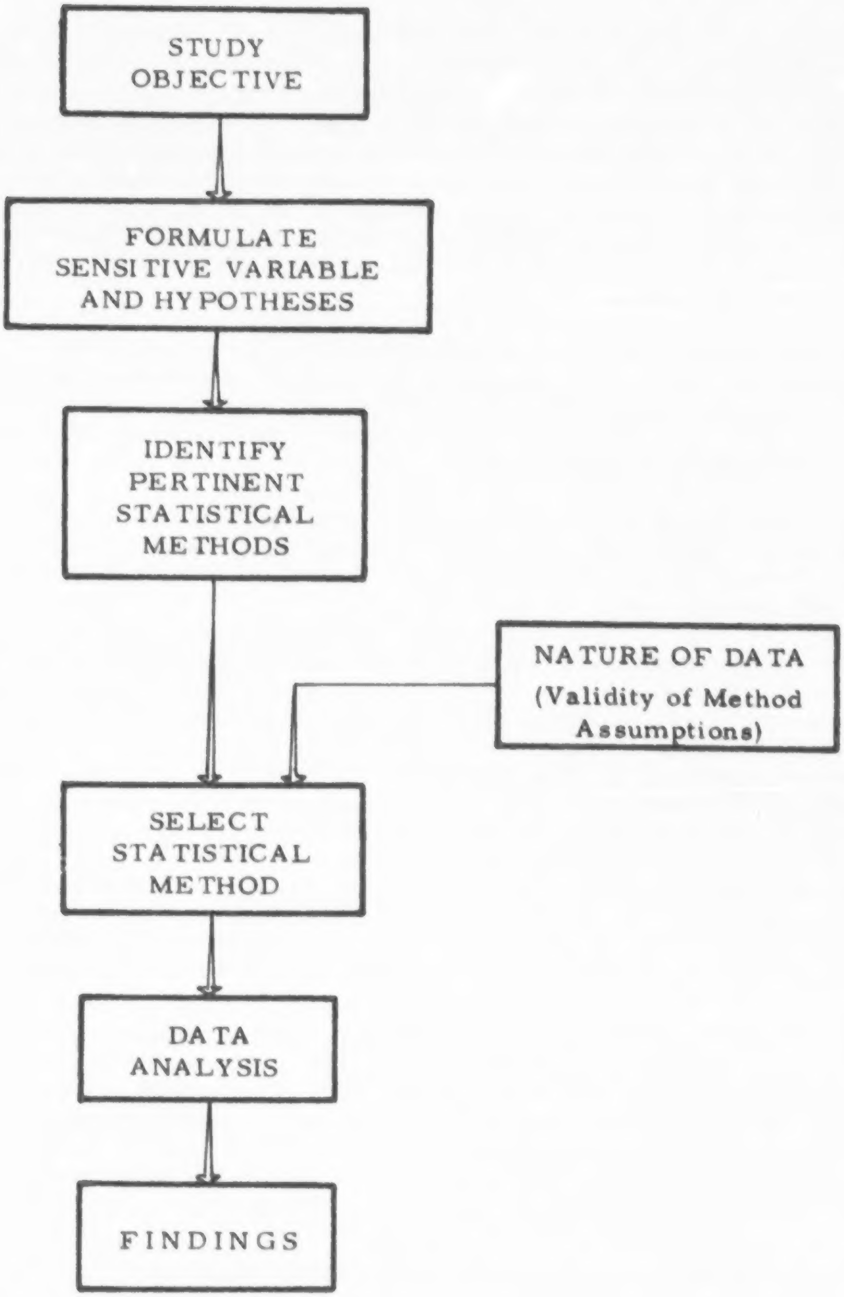

STUDY OBJECTIVE
FORMULATE SENSITIVE VARIABLE AND HYPOTHESES
IDENTIFY PERTINENT STATISTICAL METHODS
NATURE OF DATA (Validity of Method Assumptions)
SELECT STATISTICAL METHOD
DATA ANALYSIS
FINDINGS

Figure 11. General statistical analysis methodology.

The validity of the assumptions of each potential method about the nature of the data to be analyzed have been considered in selecting the most appropriate method. Parametric methods make a distributional assumption, and their validity depends upon the appropriateness of the assumed distribution. The more sensitive parametric methods generally assume the data are normally distributed. However, logarithmic transformation of the data permits application of the same methods for lognormally distributed data, which frequently occur in environmental and health monitoring.

Inspection using statistics such as the coefficient of variation (defined as the standard deviation divided by the mean) has often been used to choose the best parametric method. The degree of invalidity of the parametric method assumptions has been weighed against the inefficiency (loss of power in rejecting the null hypothesis when it is false) of using the analogous non-parametric method to select the best statistical method. Because of the importance of this study, we have generally taken the conservative approach of using non-parametric methods when the disadvantages of both methods appeared to be equal. In some cases, both methods have been applied to the data, and we have reported the consistency of their results.

The selected statistical method was then used to analyze the data and make our findings about the research question. Some sets of data contained "less than" values, where the measurement was below the analytical detection limit. When they constituted a small proportion of the sample, these less than values were replaced by half the lower detection limit and used in the data analysis. Similarly, occasional "greater than" values, above the upper detection limit, were replaced by twice the upper limit and retained in the data analysis. However, when the "less than" values occurred often enough to invalidate the method assumptions, no statistical analysis was conducted. As mentioned above, the P value associated with each test result was used to interpret the relative significance of the finding regarding the research question.

SECTION 6

RESULTS

ENVIRONMENTAL MONITORING

Aeration Basin Samples

Table 9 reports the results of the UTSA microbial characterization of two large volume aeration basin samples taken in Period 5. The table shows the standard analyses, bacterial screen, and the distribution obtained from Enterobacteriaceae testing of the two grab samples. It should be noted that the levels of several pathogenic and potentially pathogenic genera - Klebsiella, Mycobacteria and Staphylococcus - were fairly high relative to the microbiological indicator levels.

Samples of the mixed liquor were taken from an aeration basin along with each high volume aerosol sampling run and microbiological analyses for standard plate count, total coliform and fecal coliform were performed. The samples from both Period 4 and Period 5 were analyzed for these three indicators; in addition, Period 5 samples were analyzed for coliphage. The microbiological concentrations obtained from these analyses, conducted by Aqualab, are reported in Tables 10 and 11. Note that the sample concentrations obtained from the second stage aeration basin in Period 4 are much lower than those obtained from the first stage aeration basin in Periods 4 and 5.

Assays of the Period 4 samples were also conducted by SFRE. These analyses assayed for pathogenic and potentially pathogenic bacteria (Salmonella, Shigella, Proteus, Pseudomonas, Mycobacterium tuberculosis, fecal Streptococci, etc.) and enteroviruses, in addition to the microbiological indicators. All of these Period 4 aeration basin sample analyses for pathogenic bacteria and enteroviruses were negative. SFRE did quantify the indicators, fecal coliform and the standard plate count. However, the SFRE levels were very low compared to those found by the local laboratory, Aqualab.

The daily composite aeration basin samples taken in Period 5 were analyzed for selected pathogenic bacteria and enteroviruses by UTSA and for the indicator organisms by Aqualab. Table 12 reports the microbiological concentrations for these composite aeration basin samples. Comparison of the indicator levels with those found in the grab samples from the first stage aeration basin show them to be quite comparable. The pathogenic bacteria selected for analysis were Proteus, Pseudomonas, fecal Streptococci, Salmonella, and Shigella; the concentrations are reported as cfu/100 ml (colony forming units per 100 milliliters). Proteus, Salmonella, and Shigella were not detected in these samples. Pseudomonas and fecal Streptococci, however, were consistently found, giving geometric means of 855 cfu/100 ml and 74.4 cfu/100 ml, respectively. Various other bacteria were also detected; these are reported in the footnote of Table 12. Also noted is the loss of sensitivity for Proteus, Salmonella and Shigella in some samples due to overgrowth of other organisms at high dilutions. In addition, the laboratory reported that a few of the samples were received at a temperature above the desired 4°C.

TABLE 9. UTSA MICROBIAL CHARACTERIZATION OF PERIOD 5 AERATION BASIN GRAB SAMPLES

	9/28/76	10/11/76
Sample Temperature	6°C	9°C
Standard Analyses:	cfu/100 ml	cfu/100 ml
Proteus	<30,000	<50,000
Pseudomonas	3,300,000	970,000
Fecal Streptococci	720,000	1,000,000
Salmonella	<30,000	<50,000
Shigella	<30,000	<50,000
	pfu/ℓ	pfu/ℓ
Coliphage	350,000	230,000
Enteroviruses – 3-day plaques	242	*
Enteroviruses – 5-day plaques	162	*
Bacterial Screen:	cfu/100 ml	cfu/100 ml
Citrobacter	<300	50,000
Clostridium	1,500	280
Edwardsiella	<300	50,000
Enterobacter	20,000	3,000,000
Escherichia H_2S^+	<300	1,000,000
Fecal Coliform	100,000	10,000,000
Klebsiella	100,000	6,000,000
Leptospira	2,400	4,600
Mycobacteria	130,000	70,000
Providencia	<300	1,000,000
Serratia	<300	<50,000
Staphylococcus	200,000	300,000
Total Coliform	3,700,000	110,000,000
Total Plate Count	820,000,000	580,000,000
Yersenia	ND	ND
Distribution from Enterobacteriaceae Testing:	%	%
Oxidase positive	68.4	44.9
Enterobacter	7.0	14.4
Klebsiella	1.7	14.4
Proteus	–	1.4
Providencia	–	1.4
Escherichia	–	1.4
No growth	22.8	4.3
Not identified	–	17.3

*Solid fraction sample was contaminated; concentration is greater than liquid fraction sample (cf. Table 13).

TABLE 10. MICROBIOLOGICAL CONCENTRATIONS IN PERIOD 4 AERATION BASIN SAMPLES TAKEN WITH HIGH VOLUME AEROSOL SAMPLING RUNS

High Volume Run Number	Date	Standard Plate Count (No./100 ml) $\times 10^6$	Total Coliform (mfc/100 ml) $\times 10^6$	Fecal Coliform (mfc/100 ml) $\times 10^6$
Second Stage Aeration Basin Composite Sample				
1	2-9-76	600	0.22	0.002
2	2-10-76	80	0.42	0.012
3	2-11-76	33	0.56	0.0009
4	2-12-76	28	0.22	0.010
5	2-13-76	72	0.09	0.017
6	2-14-76	86	0.46	0.350
7	2-15-76	78	0.52	0.040
Geometric Mean		80	0.31	0.013
Arithmetic Mean		140	0.36	0.062
Standard Deviation		204	0.18	0.128
First Stage Aeration Basin Grab Sample				
4	2-12-76	9,700	23	1.0

TABLE 11. MICROBIOLOGICAL CONCENTRATIONS IN PERIOD 5 FIRST STAGE AERATION BASIN GRAB SAMPLES TAKEN WITH HIGH VOLUME AEROSOL SAMPLING RUNS

High Volume Run Number	Date	Standard Plate Count (No./100 ml) $\times 10^6$	Total Coliform (mfc/100 ml) $\times 10^6$	Fecal Coliform (mfc/100 ml) $\times 10^6$	Coliphage (pfu/ℓ) $\times 10^3$
1	10-1-76	640	42	2.9	93
2	10-4-76	1,270	44	2.1	380
3	10-4-76	146	42	1.7	270
4	10-5-76	2,870	39	1.9	120
5	10-6-76	1,260	72	6.1	300
6	10-7-76	490	46	2.2	230
7	10-7-76	360	41	2.5	200
8	10-7-76	700	43	1.2	34
9	10-8-76	580	27	2.0	41
10	10-8-76	220	23	0.76	51
Geometric Mean		607	40.2	2.03	127
Arithmetic Mean		854	41.9	2.34	172
Standard Deviation		805	13.0	1.45	122

TABLE 12. MICROBIOLOGICAL CONCENTRATIONS IN PERIOD 5 COMPOSITE AND CHARACTERIZATION AERATION BASIN SAMPLES

Sample Date	Standard Plate Count (No./100 ml) × 10^6	Total Coliform (mfc/100 ml) × 10^6	Fecal Coliform (mfc/100 ml) × 10^6	Bacteria Coliphage (pfu/ℓ) × 10^3	Proteus (cfu/100 ml) × 10^3	Pseudomonas (cfu/100 ml) × 10^3	Fecal Streptococci (cfu/100 ml) × 10^3	Salmonella (cfu/100 ml) × 10^3	Shigella (cfu/100 ml) × 10^3	Enteroviruses 3-Day Plaques pfu/ℓ	5-Day Plaques pfu/ℓ
Composite Samples											
10-2-76	405	57	3.3	200	<0.33	1,400	86	<0.33	<0.33	<24	<19
10-4-76	860	45	14.3	190	<0.5	1,700	20	<0.5	<0.5	192	192
10-5-76	2,960	38	2.4	150	<1.0	440	2.1	<1.0	<1.0	503	503
10-6-76	490	44	1.7	120	<300*	480	590	<300*	<300*	284	284
10-7-76	370	39	2.6	200	<200*	800	330	<200*	<200*	134	146
10-8-76	540	50	1.4	51	<2,000*	180	15	<2,000*	<2,000*	†	†
10-9-76	210	21	0.84	36	<2,000*	4,600	1,200	<2,000*	<2,000*	277	277
Geometric Mean	577	40.4	2.49	114		855	74.4			114.0	114.0
Arithmetic Mean	834	42	3.79	135		1,370	320			203.3	204.9
Standard Deviation	959	11.3	4.71	69.3		1,520	445			171.5	171.0
Characterization Samples											
9-28-76	87,000	69	0.4	350	<30	3,300	720	<30	<30	242	242
10-11-76	360	32	1.6	230	<50	970	1,000	<50	<50	†	†

Note: Other Organisms: 10-2 Escherichia – 2.3 × 10^4 cfu/100 ml, Enterobacter – 3.6 × 10^6 cfu/100 ml; 10-5 Serratia – 3.0 × 10^6 pfu/100 ml, Enterobacter – 1.4 × 10^7 cfu/100 ml; 10-6 Serratia – 8.0 × 10^6 pfu/100 ml, Citobacter, Enterobacter; 10-7 Enterobacter – 3.1 × 10^9 cfu/100 ml, Escherichia – 1.0 × 10^8 cfu/100 ml; 10-8 Enterobacter – 9.0 × 10^8 cfu/100 ml.

*Sensitivity for Proteus, Salmonella and Shigella lost due to overgrowth of other organisms at high dilutions.

†Solid fraction sample was contaminated; concentration is greater than liquid fraction sample (cf. Table 13).

The enterovirus concentrations are summarized in Table 12 and reported by sample fraction in Table 13. The concentrations are given in pfu/ℓ (plaque-forming units per liter). For two of the samples (one composite and one characterization), the solid fraction sample was contaminated. The values for these two samples are reported as > (greater than), because the concentrations were greater than the upper detection level in the liquid fraction. The geometric mean concentrations of the 3-day and 5-day plaques were both 114 pfu/ℓ, indicating that most of the enteroviruses detected were 3-day plaques - presumably polioviruses (cf. Section 5). Comparison of the geometric mean concentrations of the solids and liquid fractions for the 3-day plaques (202 pfu/ℓ vs. 40 pfu/ℓ) indicates that the viable enteroviruses were primarily in the solids fraction.

TABLE 13. ENTEROVIRUS CONCENTRATIONS IN PERIOD 5 COMPOSITE AND CHARACTERIZATION AERATION BASIN SAMPLES

Enterovirus Concentrations	Composite Samples							Characterization Samples	
	10/2/76	10/4/76	10/5/76	10/6/76	10/7/76	10/8/76	10/9/76	9/28/76	10/11/76
3-Day Plaques									
Total Count (pfu/ℓ)	<24	192	503	284	134	>41	277	242	>7.0
Solids Fraction (pfu/ℓ)	<23	190	502	279	65	CS	276	202	CS
Liquid Fraction (pfu/ℓ)	< 0.04	1.5	0.71	5.0	69	41	0.94	40	7.0
Concentration Efficiency (%)	50	48	98	30	30	89	78	92	25
5-Day Plaques									
Total Count (pfu/ℓ)	<19	192	503	284	146	>43	277	242	>7.0
Solids Fraction (pfu/ℓ)	<19	190	502	279	65	CS	276	202	CS
Liquid Fraction (pfu/ℓ)	< 0.6	1.5	0.71	5.0	81	43	0.94	40	7.0
Concentration Efficiency (%)	50	48	98	30	30	89	78	92	25

Inspection of the microbiological concentrations reveals that the distribution of some of the parameters is highly skewed, due to one or more unusually high values. This becomes particularly evident when the geometric and arithmetic means are compared; for the standard plate count, fecal coliform, Pseudomonas, fecal Streptococci, and the 3-day and 5-day enteroviruses, these two means are quite discrepant.

The trace metal concentrations found in the aeration basin samples for Periods 4 and 5 are shown in Tables 14 and 15. Whereas the composite samples for Period 4 were taken from the second stage aeration

TABLE 14. TRACE METALS CONCENTRATIONS IN PERIOD 4 SECOND STAGE AERATION BASIN COMPOSITE SAMPLES

Sampling Date	Trace Metal Concentration, mg/ℓ		
	Cadmium	Lead	Mercury
2-9-76	<0.0002	<0.0025	0.000025
2-10-76	0.0003	<0.0025	0.000071
2-11-76	0.0003	<0.0025	0.000093
2-12-76	0.0005	<0.0025	0.000061
2-13-76	0.0002	<0.0025	0.000065
2-14-76	0.0003	<0.0025	0.000036
2-15-76	<0.0002	<0.0025	0.000025
Geometric Mean	0.0002		0.000039
Arithmetic Mean	0.0003		0.000050
Standard Deviation	0.0001		0.000031
Detection Limit	0.0002	0.0025	0.000025

TABLE 15. TRACE METALS CONCENTRATIONS IN PERIOD 5
FIRST STAGE AERATION BASIN COMPOSITE SAMPLES

Sampling Date	Trace Metal Concentration, mg/ℓ		
	Cadmium	Lead	Mercury
10-2-76	0.43	1.00	0.0045
10-4-76	0.58	1.31	0.0073
10-5-76	0.57	1.26	0.0077
10-6-76	0.57	1.47	0.0053
10-7-76	0.59	1.47	0.0064
10-8-76	0.59	1.35	0.0051
10-9-76	0.53	1.18	0.0056
Geometric Mean	0.55	1.28	0.0059
Arithmetic Mean	0.55	1.29	0.0060
Standard Deviation	0.06	0.17	0.0012
Detection Limit	0.0002	0.0025	0.000025

basin, the Period 5 samples were obtained from the first stage aeration basin. Inspection of the metal concentrations for the two periods reveals that the values are consistently much lower in the second stage aeration basin. The Period 4 (second stage aeration basin) geometric mean concentrations of cadmium and mercury are 0.0002 mg/l and 0.000039 mg/l, respectively; none of the samples contained lead concentrations above the lower detection level. By comparison, the Period 5 (first stage aeration basin) geometric mean concentrations for cadmium, mercury and lead are 0.55 mg/l, 0.0059 mg/l, and 1.28 mg/l. Little daily variation was observed in the metal concentrations, as evidenced by comparing the standard deviation to the arithmetic mean to get a low coefficient of variation for each metal.

Air Samples

Meteorological and Sampling Conditions–

The meteorological conditions for all air sampling runs conducted during periods 1, 2, 4 and 5 are summarized in Tables 16-18, along with the sampling times and the alignment of the sampler line. The data presented were taken, whenever possible, from our aerosol run reports and meteorological instrumentation at the sampling site, in the earlier sampling periods. When field instrumentation was lacking, the O'Hare International Airport local climatological data were utilized. There were some differences between the O'Hare meteorological data and that collected in the field, resulting largely from differences in the location and height of the instrumentation. Whereas the field measurements were taken within a few hundred meters of the aeration basin at a height of 3.5 m, the O,Hare measurements were located eight miles east-southeast of the sewage treatment plant, with the wind instruments elevated 20 feet above ground and the temperature and humidity at the 40 foot elevation.

During Period 4, the high volume and Andersen microbiological air samples for a given run were not taken simultaneously, as they were in Period 5. Therefore, the sampling time reported is the total time for the four or five successive samples taken during each run, with each individual sample taking thirty minutes. This successive sampling procedure necessitated reporting the range of meteorological conditions over the Period 4 runs, as the wind direction, temperature, relative humidity, and sky cover usually did not remain constant over the period during which the samples were taken.

TABLE 16. METEOROLOGICAL SUMMARY FOR PERIOD 1 AND 2 HIGH VOLUME PARTICULATE AND ANDERSEN AIR SAMPLES

	High Volume Particulate Air Samples								Andersen Air Samples							
Run No.	Start Date	Start Time	Duration of Sampling (hr)	Alignment of Sampler Line (Upwind Direction*) (deg)	Temperature Range (°C)	Relative Humidity Range (%)	Wind Velocity Range (m/sec)	Sky Cover (tenths)	Start Date	Average Start Time	Duration of Sampling (min)	Alignment of Sampler Line (Upwind Direction*) (deg)	Temperature (°C)	Relative Humidity (%)	Mean Wind Velocity (m/sec)	Sky Cover (tenths)
								Period 1								
1	10-13-74	0800	24	105	12.1 - 17.2	84-90	1.5-5.5	10	10-13-74	0845	15	105	12.1	90	2.4	10
2	10-14-74	0800	24	295	2.8 - 12.7	55-86	1.8-5.5	0-10	10-14-74	0835	15	295	12.1	86	4.0	10
3	10-15-74	0800	24	305	3.3 - 13.9	44-86	0.9-3.1	1-7	10-15-74	0840	15	305	7.8	75	2.4	1
4	10-16-74	0800	24.5	215	8.9 - 17.8	38-66	1.5-4.9	0-1	10-16-74	0845	15	215	11.7	64	3.4	1
5	10-17-74	0740	24.5	230	6.7 - 18.4	33-83	3.1-5.5	0-10	10-17-74	0810	15	230	14.4	47	5.2	0
6	10-18-74	0745	25	35	2.2 - 8.3	68-89	1.5-3.7	7-10	10-18-74	0815	15	35	7.8	74	2.1	10
7	10-19-74	0830	24.5	275	2.8 - 10.0	57-85	1.5-4.6	10	10-19-74	0855	15	275	5.6	83	2.1	10
								Period 2								
1	1-26-75	1020	23	280	-5.6 - -0.6	64-85	0.9-5.5	4-10	1-26-75	1010	15	280	-5.0	69	4.9	7
2	1-27-75	0920	24	125	-1.7 - 2.2	62-85	0-4.3	10	1-27-75	1005	15	125	-1.1	74	1.8	10
3	1-28-75	0935	25	80	2.2 - 3.9	65-96	1.2-5.5	9-10	1-28-75	1020	15	80	2.8	71	3.7	9
4	1-29-75	0925	24.5	280	-3.9 - 2.2	69-85	0-6.7	0-10	1-29-75	1010	15	280	1.7	80	5.8	10
5	1-30-75	0920	24	5	-5.6 - 0	72-85	1.5-3.7	10	1-30-75	1000	15	5	-1.7	79	2.1	10
6	1-31-75	0910	25	30	-5.6 - 1.1	64-79	1.8-3.7	8-10	1-31-75	0940	15	30	-4.4	73	1.8	10
7	2-1-75	1005	23.5	45	-5.0 - 1.7	62-92	0-3.4	0-10	2-1-75	1040	15	45	1.1	64	3.4	10

* 0°, 360° = N
90° = E
180° = S
270° = W

TABLE 17. METEOROLOGICAL SUMMARY FOR PERIOD 4 AND 5 HIGH VOLUME PARTICULATE SAMPLES

	High-Volume Particulate Air Samples							
Run No.	Start Date	Avg Start Time	Average Duration of Sampling (hr)	Alignment of Sampler Line (Upwind Direction*) (deg)	Temperature Range (°C)	Relative Humidity Range (%)	Wind Velocity Range (m/sec)	Sky Cover (tenths)
Period 4								
1	2-9-76	1200	23	160-215	3.3-11.1	68-77	3.1-6.1	3-10
2	2-10-76	1500	24.5	230-320	1.7-12.1	38-79	1.5-6.1	0-10
3	2-11-76	1535	20	170-270	1.1-12.7	38-62	1.5-6.1	0-10
4	2-12-76	1330	22.5	0-180	6.1-12.7	33-80	0.9-4.6	0-10
5	2-13-76	1330	22	120-340	-3.3-4.4	35-78	0.8-4.6	0-10
6	2-14-76	1230	25	120-230	5.0-17.2	30-80	3.1-7.6	7-10
7	2-15-76	1630	18	30-255	2.8-15.0	54-82	0.9-4.6	1-10
7	2-16-76	0730	21.5	30-120	2.2-6.1	74-89	1.5-3.7	10
Period 5								
1	9-30-76	1050	23.5	220-280	8.3-24.4	33-80	0-3.1	0-1
2	10-1-76	1200	23	155-300	9.4-26.2	33-83	0-2.7	0
3	10-2-76	1050	23.5	140-305	12.1-25.0	47-90	1.2-3.7	0-10
4	10-3-76	1000	23	100-170	12.1-26.2	38-69	1.8-3.4	1-10
5	10-4-76	1045	21.5	150-270	10.6-26.2	38-90	0-4.9	7-10
6	10-6-76	0945	25	300-350	7.3-13.3	42-66	2.4-5.2	2-10
7	10-7-76	1035	23.5	300-45	7.8-9.5	66-71	1.2-2.4	8-10

* 0°, 360° = N
90° = E
180° = S
270° = W

TABLE 18. METEOROLOGICAL SUMMARY FOR PERIOD 4 AND 5 HIGH VOLUME AND ANDERSEN SAMPLING RUNS

Run No.	Date	Time	Alignment of Sampler Line (Upwind Direction*) (deg)	Wind Direction about Sampler Line (deg)	Temperature (°C)	Relative Humidity (%)	Mean Wind Velocity (m/sec)	Sky Cover (tenths)	Mean Solar Radiation (g cal/cm² /min)
Period 4 (High Volume and Andersen Samplers)									
1	2-9-76	1120-1730	0		2.2-6.1	71-79	4.2	10	
2	2-10-76	1115-1645	220-295		7.8-11.1	72-74	3.9	10	
3	2-11-76	0906-1543	320		2.2-4.4	36-70	4.1	0-6	
4	2-12-76	1020-1900	210		7.3-10.6	55-72	4.7	2-10	
5	2-13-76	0835-1458	3-12		6.1-3.3	39-60	3.9	10	
6	2-14-76	0815-1452	120-180		0.6-7.8	30-76	3.5	2-8	
7	2-16-76	0829-0859	45		3	71	1.8	10	
Period 5 (High Volume Samplers)									
1	10-1-76	1150-1220	195	(−40, +35)	24.2	43	2.4	0	1.80
2	10-3-76	1850-1920	90	(−15, 0)	19.2	67	0.8	10	0.00
3	10-4-76	0600-0630	125	(−15, +40)	11.1	78	0.3	1	0.00
4	10-4-76	1830-1900	135	(−5, +25)	23.3	45	1.5	3	0.00
5	10-6-76	1230-1300	0	(−50, +5)	11.6	55	3.1	5	1.00
6	10-6-76	1920-1950	0	(−5, +15)	7.5	58	2.1	8	0.00
7	10-7-76	0530-0600	325	(−5, +45)	7.5	70	1.8	10	0.00
8	10-7-76	1400-1430	0	(−40, +5)	8.3	70	1.5	10	0.10
9	10-8-76	0555-0625	295	(+5, +45)	6.2	80	1.7	9	0.00
10	10-8-76	1515-1545	265	(−40, +25)	12.4	48	1.5	8	0.45
Period 5 (Andersen Samplers)									
1	9-29-76	1215-1300	250	(−30, +30)	18.3	62	1.5-3.1	8-9	0.60
2	10-7-76	1445-1515	0	(−25, +15)	8.3	70	1.5	10	0.05

*0°, 360° = N
90° = E
180° = S
270° = W

The daily resultant wind directions at O'Hare International Airport were tabulated for the study period during which the Egan plant was in operation (January through October, 1976). The wind rose diagram giving the distribution of daily resultant directions from which the wind blew over this operational period is presented in Figure 12. The wind rose diagram indicates that the prevailing wind directions in the vicinity of the Egan plant were primarily from the southwest and south, and secondarily from the north-northeast during the operational period. Thus it is anticipated that there would be greater exposure to the microorganisms in the aerosol emanating from the Egan plant's aeration basins for the residences located to the northeast, south-southwest, and north than for residences in other directions. Exposure should be least for residences situated west and northwest of the Egan aeration basins.

LOCATION: O'HARE INTERNATIONAL AIRPORT CHICAGO, ILLINOIS

PERIOD: JANUARY – OCTOBER, 1976

OBSERVATION: DAILY RESULTANT WIND DIRECTION

NO. OF OBSERVATIONS: 305 DAYS

SOURCE: LOCAL CLIMATOLOGICAL DATA, NATIONAL CLIMATIC CENTER

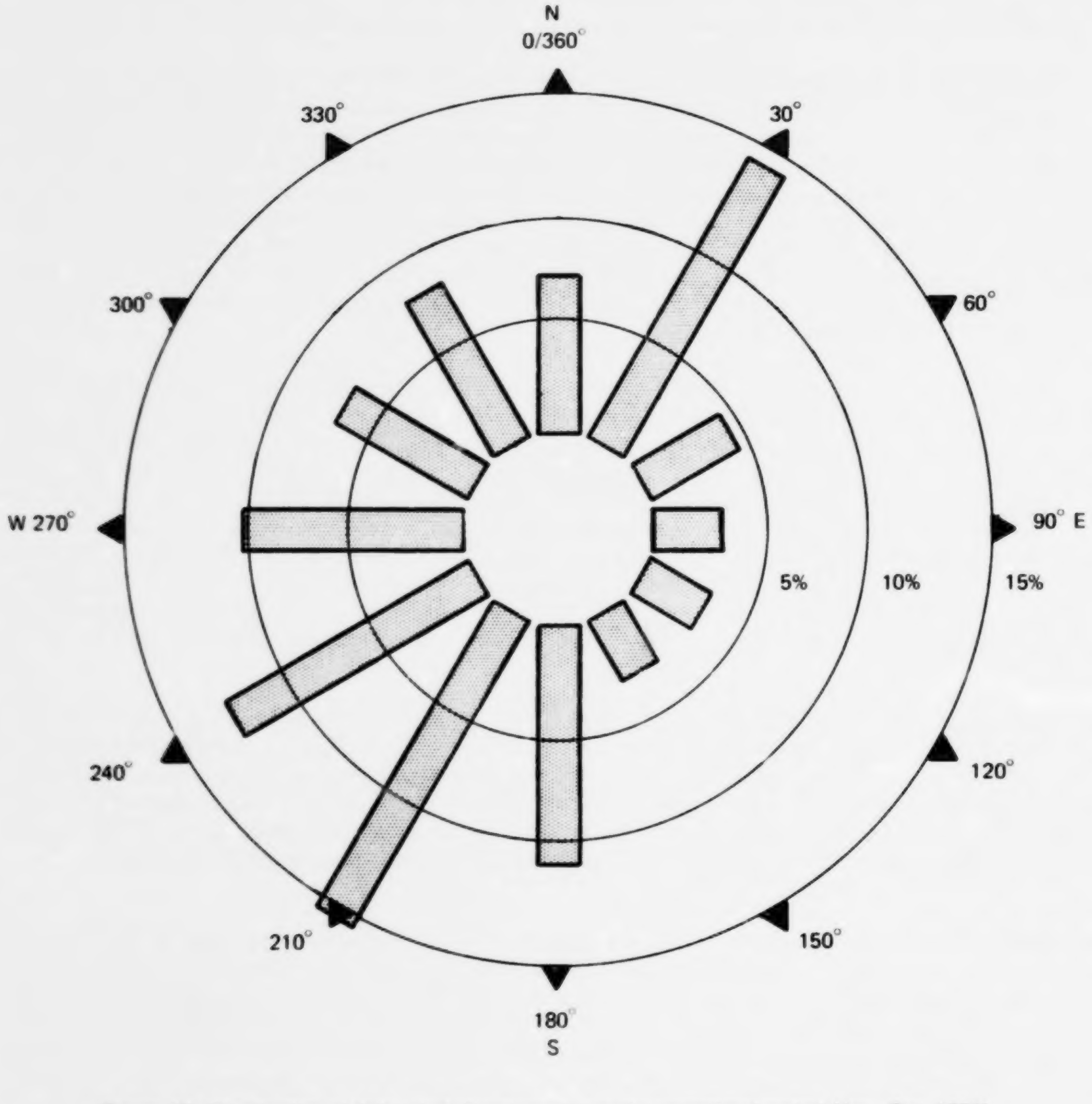


Figure 12. Distribution of daily wind directions during the operational period (Jan - Oct, 1976).

Microbiology--

Microbiological Concentration and Isolation Data--The microbiological concentrations obtained from the air samplers are reported in Tables 19-21. Distances are measured from the nearest edge of the first stage aeration basin in the alongwind direction. Table 19 gives the analytical results for the Andersen air samples taken in Periods 1, 2 and 4. The pathogenic and potentially-pathogenic bacteria sought were Mycobacterium tuberculosis, Proteus, Pseudomonas, Salmonella, Shigella, Staphylococcus Aureus and S. epidermidis, and Streptococcus (alpha, beta, and gamma). No pathogenic bacteria were isolated in Periods 1 or 2. In Period 4, Pseudomonas were isolated in three of the downwind samples and Streptococcus-alpha was found in one sample. Table 20 gives the indicator concentrations and pathogen isolations found for the Period 4 high volume samplers. Table 20 shows one sample with a Pseudomonas isolate, but because the air sample was collected 1570 m upwind, the sewage treatment plant is unlikely to have been the source. Excluding the sample concentrations inferred to be affected by contamination, the levels for the three microbiological indicators have consistently higher values for the aerosol samples taken close downwind from the aeration basin.

Table 21 reports the microbiological concentrations for the Period 5 high volume sampling runs. These samples were subjected to more extensive and quantitative analyses, including four microbiological indicators (standard plate count, total coliform, fecal coliform, and coliphage), selected pathogenic bacteria (Proteus, Pseudomonas, fecal Streptococci, Salmonella, and Shigella), and 3-day and 5-day enteroviruses. Of the bacteria selected, no Proteus, fecal Streptococci, Salmonella, or Shigella were detected in any air sample. However, Pseudomonas was found in every run. Klebsiella was also isolated in several samples, even out to a distance of 300 meters from the plant. A single enterovirus (poliovirus type III) was detected in the air samples; this was on Run 6 in a sample taken 300 meters downwind. The indicator levels show a rapid decrease in concentration with distance from the plant. Other organisms isolated and their quantified concentrations are reported in the footnote of Table 21.

It is our experience from air sampling both at the Egan plant and at Pleasanton[44] (conducted with the same samplers both before and after Period 5) that high volume aerosol samplers are essential to obtain quantitative microbiological aerosol concentrations, especially on pathogens. However, the high volume aerosol samplers have a tendency to become and remain contaminated with some of the hardy microorganisms, such as Pseudomonas, in parts that are unaffected by our thorough routine cleaning procedures. The primary evidence of sampler contamination is usually an extremely high standard plate count, which persists in the sampler over several consecutive runs. Since these analytical results are not available to the field crew until the next day, the sampler contamination problem is difficult to detect and correct in the field. As indicated in Table 21, Sampler 3 shows this evidence of contamination in Runs 1 through 4. Laboratory notations indicating possible sample contamination of either field or laboratory origin are also reported in Table 21.

Because the large values associated with sampler contamination will dominate the statistical analysis, general criteria have been developed for inferring sample contamination that has affected the analytical value, based on combined experience in Pleasanton and at the Egan plant. The values inferred to be affected by sampler contamination have been underlined in Tables 20 and 21. The ensuing statistical analyses have been conducted both excluding and including these underlined values. The specific criteria for inferring possible sample contamination in the Chicago data, signified by underlining the affected value, are given below.

Standard plate count values $\geq 30{,}000/m^3$ were judged to be contaminated. The basis for this criterion value was the observation of a consistent pattern of high values for a particular sampler over several runs, or indication of contamination by the laboratory. Total and fecal coliform values were considered contaminated if they showed an unusual value in addition to some indication of sampler contamination by the laboratory or the corresponding standard plate count value. Pseudomonas concentrations were underlined in the table if they showed unusual values along with standard plate count indications of sampler contamination, or if they showed very unusual values coupled with sampler contamination in the run immediately preceding or following the one in question. For Pseudomonas, this procedure resulted in a criterion value of ≥ 3000 cfu/m^3.

TABLE 19. PATHOGEN ISOLATIONS FROM PERIOD 1, 2 AND 4 ANDERSEN AIR SAMPLES

Period 1					Period 2					Period 4				
Date	Approx. Distance (m)	Pathogens	Predominant Organism	Standard Plate Count (No./m³)	Date	Approx. Distance (m)	Pathogens	Predominant Organism	Standard Plate Count (No./m³)	Date	Distance (m)	Pathogens	Predominant Organism	Standard Plate Count (No./m³)
Residential Upwind (>300 m)														
10-13-74	1600 U	None	Bacillus	32	1-27-75	1600 U	None	Bacillus	8	2-9-76	1632 U	None	Bacillus	15
10-14-74	5000 U	None	Bacillus	34	1-27-75	500 U	None	Bacillus	72	2-10-76	1570 U	None	Bacillus	14
10-15-74	1600 U	None	Bacillus	61	1-28-75	1600 U	None	Various	2	2-11-76	580 U	None	Bacillus	21
10-16-74	1600 U	None	Bacillus	37	1-28-75	500 U	None	Various	12	2-12-76	928 U	None	Bacillus	66
10-16-74	5000 U	None	Bacillus	35	1-29-75	500 U	None	Bacillus	5	2-13-76	660 U	None	Bacillus	19
10-17-74	1600 U	None	Bacillus	2						2-14-76	1348 U	None	Bacillus	51
10-18-74	1600 U	None	Bacillus	8										
10-19-74	1600 U	None	Bacillus	34										
Geometric Mean				22					9					26
Arithmetic Mean				30					20					31
Standard Deviation				18					29					22
Sewage Treatment Plant (≤ 300 m)														
10-13-74	50 D	None	Bacillus	11	1-26-75	50 D	None	Bacillus	471	2-9-76	252 D	None	Bacillus	205
10-14-74	50 D	None	Bacillus	309	1-27-75	50 D	None	Bacillus	22	2-9-76	1 D	(2) Pseudomonas	Bacillus	>1200
10-15-74	50 D	None	Bacillus	61	1-28-75	50 D	None	Various	15	2-10-76	107 D	(1) Pseudomonas	Bacillus	80
10-16-74	50 D	None	Bacillus	511	1-29-75	50 D	None	Bacillus	19	2-10-76	7 D	None	Bacillus	>1200
10-17-74	5 D	None	Bacillus	27	1-30-75	50 D	None	Bacillus	36	2-11-76	170 D	None	Bacillus	39
10-17-74	50 D	None	Bacillus	52	1-31-75	50 D	None	Bacillus	14	2-11-76	18 D	None	Bacillus	166
10-18-74	50 D	None	Bacillus	25	2-1-75	5 D	None	Bacillus	6	2-12-76	114 D	None	Various	438
10-19-74	50 D	None	Bacillus	18	2-1-75	50 D	None	Bacillus	11	2-12-76	20 D	None	Various	392
										2-13-76	26 D	None	Bacillus	314
										2-14-76	1 D	None	Bacillus	242
Geometric Mean				53					24					269
Arithmetic Mean				127					74					428
Standard Deviation				184					161					426

(continued)

TABLE 19. (continued)

Period 1					Period 2					Period 4				
Date	Approx. Distance (m)	Pathogens	Predominant Organism	Standard Plate Count (No./m³)	Date	Approx. Distance (m)	Pathogens	Predominant Organism	Standard Plate Count (No./m³)	Date	Distance (m)	Pathogens	Predominant Organism	Standard Plate Count (No./m³)
Residential Downwind (>300 m)														
10-13-74	500 D	None	Bacillus	—	1-26-75	500 D	None	Bacillus	21	2-9-76	660 D	None	Bacillus	13
10-13-74	1600 D	None	Bacillus	18	1-26-75	1600 D	None	Bacillus	4	2-10-76	830 D	None	Bacillus	59
10-14-74	1600 D	None	Bacillus	245	1-26-75	5000 D	None	Bacillus	7	2-11-76	2230 D	None	Bacillus	16
10-14-74	5000 D	None	Bacillus	258	1-27-75	1600 D	None	Various	240	2-11-76	800 D	None	Bacillus	12
10-15-74	1600 D	None	Bacillus	24	1-28-75	1600 D	None	Bacillus	1	2-12-76	1500 D	None	Bacillus	58
10-15-74	1600 D	None	Bacillus	339	1-29-75	500 D	None	Bacillus	27	2-12-76	844 D	None	Diphtheroid	51
10-16-74	1600 D	None	Bacillus	38	1-29-75	1600 D	None	Bacillus	26	2-12-76	384 D	Pseudomonas	Bacillus	134
10-17-74	1600 D	None	Bacillus	12	1-30-75	500 D	None	Bacillus	27	2-13-76	4228 D	None	None	<1
10-18-74	1600 D	None	Bacillus	159	1-30-75	1600 D	None	None	<1	2-13-76	1892 D	None	Bacillus	24
10-18-74	5000 D	None	Bacillus	33	1-30-75	5000 D	None	Bacillus	44	2-13-76	1268 D	Streptococcus-alpha	Streptococcus-alpha	114
10-19-74	1600 D	None	Bacillus	185	1-31-75	500 D	None	Bacillus	39	2-13-76	480 D	None	Bacillus	8
10-19-74	5000 D	None	Bacillus	135	1-31-75	1600 D	None	Bacillus	22	2-14-76	820 D	None	Bacillus	60
					1-31-75	5000 D	None	Bacillus	15	2-14-76	615 D	None	Bacillus	60
					2-1-75	1600 D	None	Diphtheroid	8	2-14-76	388 D	None	Bacillus	41
					2-1-75	1600 D	None	Micrococcus	258	2-14-76	340 D	None	Bacillus	26
					2-1-75	5000 D	None	Bacillus	12					
Geometric Mean				77					16					27
Arithmetic Mean				131					47					45
Standard Deviation				115					80					38

TABLE 20. MICROBIOLOGICAL CONCENTRATIONS IN PERIOD 4 HIGH VOLUME AEROSOL SAMPLING RUNS

Time	Distance (m)	Sampler No.	Standard Plate Count (No./m³)	Total Coliform (mfc/m³)	Fecal Coliform (mfc/m³)	Pathogens Isolated
Run No. 1, 2-9-76						
1120-1150	660 D	1	30,000	<0.3	<0.3	None
1305-1410	1632 U	1	13,000	<0.3	<0.3	None
1519-1553	252 D	1	6,200	1.5	<0.3	Streptococcus-alpha
1700-1730	1 D	1	120,000	200	8.9	Streptococcus-alpha
Run No. 2, 2-10-76						
1115-1145	1570 U	1	890	0.3	<0.3	Pseudomonas
1245-1315	830 D	1	1,200	<0.3	<0.3	None
1450-1520	107 D	1	1,200	1.2	<0.3	None
1615-1645	7 D	1	35,000	210	8.3	None
Run No. 3, 2-11-76						
0906-0936	580 U	1	590	0.3	<0.3	None
1128-1158	2230 D	1	890	< 0.3	<0.3	None
1230-1300	800 D	1	1,200	<0.3	<0.3	Streptococcus-alpha
1419-1449	170 D	1	590	<0.3	<0.3	Streptococcus-alpha
1513-1543	18 D	1	8,900	13	0.3	None
Run No. 4, 2-12-76						
1020-1050	928 U	1	83,000	<0.3	<0.3	None
1124-1154	1500 D	1	53,000	<0.3	<0.3	None
1430-1500	844 D	1	41,000	<0.3	<0.3	None
1533-1603	384 D	1	3,200	<0.3	<0.3	None
1735-1805	114 D	1	8,900	3.0	<0.3	None
1830-1900	20 D	1	77,000	140	1.2	None
Run No. 5, 2-13-76						
0835-0905	660 U	1	1,500	<0.3	<0.3	None
1005-1035	4228 D	1	1,200	<0.3	<0.3	None
1107-1137	1892 D	1	1,500	<0.3	<0.3	None
1210-1240	1268 D	1	890	<0.3	<0.3	None
1316-1346	480 D	1	1,800	0.3	<0.3	None
1428-1458	26 D	1	13,000	4.7	0.3	None
Run No. 6, 2-14-76						
0819-0849	1348 U	1	1,200	<0.3	<0.3	None
0945-1015	820 D	1	650	<0.3	<0.3	None
1047-1117	615 D	1	970	<0.3	<0.3	None
1152-1222	388 D	1	590	<0.3	<0.3	None
1300-1330	340 D	1	3,500	0.3	<0.3	None
1422-1452	1 D	1	14,900	10	1.8	Streptococcus-alpha
Run No. 7, 2-16-76						
0829-0859	3620 U	1	1,500	<0.3	<0.3	None

Underlined value: sample contamination affecting result inferred.
Note: Other organisms isolated were Bacillus, E. coli, Enterobacter, Diphtheroid and Micrococcus.

TABLE 21. MICROBIOLOGICAL CONCENTRATIONS IN PERIOD 5 HIGH VOLUME AEROSOL SAMPLING RUNS

			Indicators				Pathogenic Bacteria					Enteroviruses		
Run No. (Date) Time	Distance (meters)	Sampler Number	Standard Plate Count No./m^3	Total Coliform mfc/m^3	Fecal Coliform mfc/m^3	Coliphage pfu/m^3	Proteus cfu/m^3	Pseudomonas cfu/m^3	Fecal Streptococci cfu/m^3	Salmonella cfu/m^3	Shigella cfu/m^3	3-Day Plaques pfu/m^3	5-Day Plaques pfu/m^3	Klebsiella Isolated
1	500 U	6	120	0.6	< 0.3	< 0.15	< 10	< 10	< 10	< 10	< 10	< 0.18	< 0.38	No
(10-1-76)	15 D	5	510,000	1.3	0.5	< 0.13†	< 9	< 9	< 9	< 9	< 9	< 0.16	< 0.35	Yes
1150-1220	250 D	7	950	< 0.3	< 0.3	< 0.13	< 9	34	< 9	< 9	< 9	< 0.18	< 0.36	No
	310 D	2	530	< 0.3	< 0.3	< 0.17†	< 11	22	< 11	< 11	< 11	< 0.23	< 0.50	No
	1000 D	4	500	< 0.3	< 0.3	< 0.17†	< 9	36	< 9	< 9	< 9	< 0.16	< 0.35	No
	1600 D	3*	200†	54†	51†	< 0.17†	< 11	8,700*	< 11	< 11	< 11	< 0.20	< 0.43	No
2	960 U	8	270*	2.7	0.7	< 0.17	< 11	< 11	< 11	< 11	< 11	< 0.20	< 0.43	No
(10-4-76)	25 D	3*	2,900,000	93	1.3	< 0.17	< 11	< 11	< 11	< 11	< 11	< 0.20	< 0.43	No
1850-1920	50 D	2	28,000	2.7	< 0.3	0.17	< 11	1,100	< 11	< 11	< 11	< 0.20	< 0.43	No
	100 D	5	980	0.3	< 0.3	< 0.13	< 9	< 9	< 9	< 9	< 9	< 0.16	< 0.35	No
	200 D	7	23,000	2.6	0.3	< 0.13	< 9	26	< 9	< 9	< 9	< 0.15	< 0.33	No
	500 D	4	2,900	< 0.3	< 0.3	< 0.14	< 9	27	< 9	< 9	< 9	< 0.16	< 0.35	No
3	960 U	8	400	2.3	< 0.3	< 0.17	< 17	1,100	< 17	< 17	< 17	< 0.20	< 0.43	No
(10-4-76)	25 D	3*	1,900,000	47	< 0.3	< 0.17	< 11	33,000	< 11	< 11	< 11	< 0.20	< 0.43	Possible
0600-0630	50 D	2	1,300	23	2.7	< 0.17	< 11	2,500	< 11	< 11	< 11	< 0.20	< 0.43	No
	100 D	5	2,000	3.7	0.8	< 0.13	< 9	< 9	< 9	< 9	< 9	< 0.16	< 0.35	Yes
	225 D	7	310	0.5	< 0.3	< 0.13	< 13	< 13	< 13	< 13	< 13	< 0.15	< 0.33	No
	1000 D	4	1,200	< 0.3	< 0.3	< 0.14	< 9	< 9	< 9	< 9	< 9	< 0.16	< 0.35	No

* Contaminated Sampler.
† Laboratory indication of contamination.
Underlined value: sample contamination affecting result inferred.

(continued)

TABLE 21. (continued)

Run No. (Date) Time	Distance (Meters)	Sampler Number	Indicators				Pathogenic Bacteria					Enteroviruses		Klebsiella Isolated
			Standard Plate Count No. /m^3	Total Coliform mfc/m^3	Fecal Coliform mfc/m^3	Coliphage pfu/m^3	Proteus cfu/m^3	Pseudomonas cfu/m^3	Fecal Streptococci cfu/m^3	Salmonella cfu/m^3	Shigella cfu/m^3	3-Day Plaques pfu/m^3	5-Day Plaques pfu/m^3	
4	960 U	8	5,000	17	0.3	< 0.17[†]	< 17	600	< 17	< 17	< 17	< 0.20	< 0.43	No
(10-5-76)	20 D	3*	4,500,000	5800	2100	< 0.17[†]	< 11	470,000	< 11	< 11	< 11	< 0.20	< 0.43	No
1830-1900	50 D	2	110,000	15	< 0.3	< 0.17[†]	< 11	< 11	< 11	< 11	< 11	< 0.20	< 0.43	No
	50 D	7	5,900	38	0.5	< 0.13[†]	< 13	< 13	130	< 13	< 13	< 0.15	< 0.33	No
	100 D	5	3,000	12	< 0.3	< 0.13	< 9	< 9	< 9	< 9	< 9	< 0.16	< 0.35	No
	300 D	4	1,400	2.2	< 0.3	< 0.14	< 9	9	< 9	< 9	< 9	< 0.16	< 0.35	Yes
5	660 U	1	32,000	0.3	< 0.3	< 0.15	< 15	< 15	< 15	< 15	< 15	< 0.24	< 0.47	No
(10-6-76)	15 D	8	8,000	1.0	< 0.3	0.17	< 17	< 17	< 17	< 17	< 17	< 0.23	< 0.47	No
1230-1300	95 D**	2	8,800	7.3	4.7	< 0.17	< 17	18,000	< 17	< 17	< 17	< 0.23	< 0.47	No
	125 D**	5	2,000	2.4	< 0.3	< 0.13	< 13	< 13	< 13	< 13	< 13	< 0.19[†]	< 0.37	No
	175 D**	7	9,700	0.8	< 0.3	< 0.13	< 13	13	< 13	< 13	< 13	< 0.18	< 0.36	Yes
	300 D**	4	6,100	0.3	< 0.3	< 0.14	< 14	< 14	< 14	< 14	< 14	< 0.38	< 0.76	No
6	660 U	1	65,000	<0.3	< 0.3	< 0.15	< 15	< 15	< 15	< 15	< 15	< 0.27	< 0.53	No
(10-7-76)	15 D	8	120,000	2.0	0.3	< 0.17	< 17	< 17	< 17	< 17	< 17	< 0.30	< 0.60	No
1920-1950	95 D**	2	130,000	4.7	0.3	< 0.17	< 17	< 11	< 17	< 17	< 17	< 0.23	< 0.47	No
	125 D**	5	11,000	2.4	< 0.3	< 0.13	< 13	< 13	< 13	< 13	< 13	< 0.21	< 0.43	No
	175 D**	7	620	1.8	< 0.3	< 0.13	< 13	< 13	< 13	< 13	< 13	< 0.21	< 0.41	No
	300 D**	4	4,600	0.5	< 0.3	0.27	< 14	14	< 14	< 14	< 14	0.22	< 0.43	No

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* Contaminated Sampler.

† Laboratory indication of contamination.

** Runs 5, 6, 7 and 8 - The second stage aeration basin occupied most of the space between the 15/20m downwind sampler and the next downwind sampler.

Underlined value: sample contamination affecting result inferred.

(continued)

TABLE 21. (continued)

Run No. (Date) Time	Distance (Meters)	Sampler Number	Indicators				Pathogenic Bacteria					Enteroviruses		Klebsiella Isolated
			Standard Plate Count No. /m^3	Total Coliform mfc/m^3	Fecal Coliform mfc/m^3	Coliphage pfu/m^3	Proteus cfu/m^3	Pseudomonas cfu/m^3	Fecal Streptococci cfu/m^3	Salmonella cfu/m^3	Shigella cfu/m^3	3-Day Plaques pfu/m^3	5-Day Plaques pfu/m^3	
7	820 U	4	8,700	< 0.3	< 0.3	0.14	< 14	3,800	< 14	< 14	< 14	< 0.19	< 0.38	No
(10-7-76)	20 D	8	670,000	4.7	0.3	< 0.17	< 17	< 17	< 17	< 17	< 17	< 0.23	< 0.47	No
0530-0600	75 D**	1	8,800	2.3	< 0.3	< 0.15	< 15	740	< 15	< 15	< 15	< 0.19	< 0.41	No
	125 D**	2	21,000	1.0	< 0.3	< 0.17	< 17	< 17	< 17	< 17	< 17	< 0.23	< 0.47	No
	200 D**	5	13,000	1.0	< 0.3	< 0.13	< 13	< 13	< 13	< 13	< 13	< 0.16	< 0.35	No
	2000 D**	7	330	0.3	< 0.3	< 0.13	< 13	13	< 13	< 13	< 13	< 0.15	< 0.33	No
8	660 U	4	19,000	0.8	< 0.3	< 0.14	< 14	< 14	< 14	< 14	< 14	< 0.16	< 0.46	Yes
(10-7-76)	15 D	8	2,800,000	5.0	0.3	< 0.17	< 17	< 17	< 17	< 17	< 17	< 0.23	< 0.47	Yes
1400-1430	97 D**	2	1,100,000	7.0	0.7	< 0.17	< 17	83	< 17	< 17	< 17	< 0.23	< 0.47	Yes
	125 D**	5	7,600	2.7	< 0.3	< 0.13	< 13	< 13	< 13	< 13	< 13	< 0.24	< 0.45	Yes
	175 D**	7	8,200	3.1	< 0.3	< 0.13	< 13	< 13	< 13	< 13	< 13	< 0.31	< 1.00	Yes
	420 D**	1	68,000	3.0	< 0.3	< 0.15	< 15	< 15	< 15	< 15	< 15	< 0.27	< 0.62	No
9	820 U	4	130,000	< 0.3	< 0.3	< 0.14	< 14	< 14	< 14	< 14	< 14	< 0.19	< 0.38	No
(10-8-76)	20 D	8	43,000	6.0	0.3	0.17	< 17	< 17	< 17	< 17	< 17	< 0.33	< 0.70	No
0555-0625	50 D	2	1,700	2.7	0.7	< 0.17	< 17	< 17	< 17	< 17	< 17	< 0.27	< 0.57	Yes
	80 D	5	28,000	0.3	< 0.3	< 0.13	< 13	< 13	< 13	< 13	< 13	< 0.19	< 0.37	No
	115 D	7	800	0.3	< 0.3	< 0.13	< 13	< 13	< 13	< 13	< 13	< 0.18	< 0.36	No
	300 D	1	6,300	0.9	< 0.3	< 0.15	< 15	560	< 15	< 15	< 15	< 0.24	< 0.62	No
10	500 U	4	19,000	1.4	< 0.3	< 0.14	< 14	< 14	< 14	< 14	< 14	< 0.22	< 0.57	Yes
(10-8-76)	22 D	5	29,000	2.0	< 0.3	0.27	< 13	400	< 13	< 13	< 13	M †	M †	No
1515-1545	22 D	2	21,000	33	< 0.3	< 0.17	< 17	170	< 17	< 17	< 17	< 0.23	< 0.57	No
	50 D	7	130	1.3	< 0.3	< 0.13	< 13	5,400	< 13	< 13	< 13	< 0.18	< 0.36	No
	600 D	1	5,000	0.6	< 0.3	< 0.15	< 15	7,100	< 15	< 15	< 15	< 0.24	< 0.50	No
	1600 D	8	170	0.7	< 0.3	< 0.17	< 17	< 17	< 17	< 17	< 17	< 0.20	< 0.47	No

NOTE: Other organisms isolated (and quantified concentrations): Citrobacter freundii - (170/m^3); Enterobacter - (26/m^3 - TNTC); Escherichia - (27/m^3 - 460m^3). Providencia, and Serratia - (100/m^3 - TNTC).

* Contaminated Sampler.

† Laboratory indication of contamination, no value reported.

M Missing Data.

Underlined value: sample contamination affecting result inferred.

Microbiological Aerosol Particle Size Distribution--Two Andersen sampler runs were conducted during Period 5 in which microbiological levels were determined for each of the six sampler stages corresponding in six particle sizes. For Run 1 (September 29, 1976), standard plate count levels were reported; for Run 2 (October 7, 1976), total coliform levels were determined. Table 22 reports the concentrations and percentage distributions for the standard plate count run and/or the total coliform run according to sampler distance and the particle diameter range for each of the six stages. In determining the percentage distributions, TNTC (too numerous to count), CS (confluent), and M (missing plate) values were ignored, because no reasonable numerical value could be found for substitution.

Examination of these tables suggests that the majority of the viable particles in the aerosol samples were in the respirable range, with most of them falling between 3.3 and 7.0 microns in diameter. As would be expected, the standard plate count data showed a broader range than the total coliform, including a sizable number of particles greater than 7.0 microns in diameter. There seemed to be no clear trend for the particle size distributions to change with sampler distance.

Microbiological Source and Distance Analysis--The statistical treatment of the microbiological aerosol data attempted to provide answers to two research questions through the use of paired comparisons. The first of these, whether the Egan sewage treatment plant was implicated as a source of the microbiological parameters measured, was considered through comparisons of upwind air samples, used as a measure of background aerosol levels, and the closest downwind air samples. For parameters showing significantly higher levels in the close downwind samples, thereby implicating the plant as a source, a further question was considered: are the downwind levels of these parameters a health concern? In considering this question, the more distance, residential downwind air samples were compared against the corresponding upwind air sample for each run.

A general methodological approach for conducting the necessary paired comparisons was formulated. The preferable method for such comparisons is the paired sample t-test which provides a very powerful test of the null hypothesis that the average difference between pair members is equal to zero. This test, however, requires two assumptions: the distribution of difference scores must be normal in shape and must be composed of a continuous variable. The difference scores for the microbiological aerosol data were generally not normally distributed due to the occurrence of isolated high values. With this type of microbiological aerosol data, comparisons utilizing proportions are considered more relevant than comparisons of differences. Since the sample sizes were typically quite small (less than 20), traditional tests for normality (skewness, kurtosis, goodness-of-fit) were not appropriate. Simple inspection of the data and its coefficient of variation served to determine if the difference scores distribution was normal. When the data were not normal, an attempt to normalize it through transformation was made. For example, a natural log transformation was useful when the differences were proportional. In cases where no normalizing transformation could be found, the t-test technique was not employed. In addition, for some cases, the assumption of variable continuity was violated; this was true for data containing many concentrations close to or below the detection level.

In cases where the data were not amenable to a paired sample t-test, the Wilcoxon one sample signed ranks test was chosen as a first alternative. This test does not require the assumptions of normality and variable continuity, as it is based on simple order relationships among the difference scores. Even here it was occasionally necessary to use natural log transformed data to account for the presence of proportional differences in the data rather than absolute values. Following Brownlee's suggestion(45) (p. 260), pairs leading to difference scores of zero were deleted from the data.

A second alternative, the sign test, was chosen for use in cases when even the rank order statistic was deemed inappropriate. This was true when the data seemed to be unreliable, as in the case of unusually large values appearing in the same run as very small values. The sign test is much more appropriate for such data, as it ignores the magnitude of a difference, and makes use simply of its direction.

TABLE 22. AEROSOL PARTICLE SIZE DISTRIBUTION FOR STANDARD PLATE COUNT AND TOTAL COLIFORM

Standard Plate Count Concentrations (No./m^3)

Sampler Number	Distance (meters)	Range of Particle Sizes (microns) >7.0 (Stage 1)	4.7-7.0 (Stage 2)	3.3-4.7 (Stage 3)	2.1-3.3 (Stage 4)	1.1-2.1 (Stage 5)	0.65-1.1 (Stage 6)
1	Upwind	168	65	TNTC	11	12	2
6	10 D	111	71	118	68	36	0
2	20 D	168	108	111	36	25	TNTC
3	50 D	TNTC	26	19	14	21	2
4	100 D	68	31	25	13	13	2
5	200 D	TNTC	14	11	14	4	0

Standard Plate Count Percentage Distribution

Sampler Number	Distance (meters)	Range of Particle Sizes (microns) >7.0 (Stage 1)	4.7-7.0 (Stage 2)	3.3-4.7 (Stage 3)	2.1-3.3 (Stage 4)	1.1-2.1 (Stage 5)	0.65-1.1 (Stage 6)
1	Upwind	65%	25%	TNTC	4%	5%	1%
6	10 D	27%	18%	29%	17%	9%	0%
2	20 D	38%	23%	25%	8%	6%	TNTC
3	50 D	TNTC	31%	23%	17%	26%	3%
4	100 D	49%	20%	16%	9%	9%	2%
5	200 D	TNTC	33%	25%	33%	8%	0%

Total Coliform Concentrations (mfc/m^3)

Sampler Number	Distance (meters)	Range of Particle Sizes (microns) >7.0 (Stage 1)	4.7-7.0 (Stage 2)	3.3-4.7 (Stage 3)	2.1-3.3 (Stage 4)	1.1-2.1 (Stage 5)	0.65-1.1 (Stage 6)
3	Upwind	0	0	1	0	0	0
2	15 D	0	5	2	0	0	0
1	97 D	5	5	2	2	0	0
6	125 D	0	0	0	0	0	0
4	175 D	0	1	1	0	0	0
5	420 D	CS	CS	0	0	CS	M

Total Coliform Percentage Distribution

Sampler Number	Distance (meters)	Range of Particle Sizes (microns) >7.0 (Stage 1)	4.7-7.0 (Stage 2)	3.3-4.7 (Stage 3)	2.1-3.3 (Stage 4)	1.1-2.1 (Stage 5)	0.65-1.1 (Stage 6)
3	Upwind	0%	0%	100%	0%	0%	0%
2	15 D	0%	67%	33%	0%	0%	0%
12	97 D	33%	33%	17%	17%	0%	0%
6	125 D	0%	0%	0%	0%	0%	0%
4	175 D	0%	50%	50%	0%	0%	0%
5	420 D	CS	CS	0%	0%	CS	M

TNTC - Too numerous to count.
CS - Contaminated sample.
M - Missing data.

The data from Periods 4 and 5 were combined when possible to increase sample sizes and resulting statistical power. In Period 4, samples were taken with both the Andersen and high volume samplers. These data were not combined, as their values are not comparable.

Some runs had missing or contaminated data for some of the air samples taken or laboratory analyses conducted. If the upwind concentration for a particular parameter was unusable for any run, that run was deleted from the analysis, as it had no valid measure of background concentrations for that parameter. If the closest downwind sample could not be used, the next closest one was substituted, with the restriction that no sample taken at a distance at or beyond 300 meters be considered a close downwind sample. All samples taken at a distance of at least 300 meters were designated as residential downwind samples. If, in the comparisons between upwind microbiological levels and residential downwind levels, more than one air sample fell into the residential category, the geometric mean was used as the comparison value.

As previously discussed, inferences of possible sample contamination were made in some cases in addition to contamination reported by the laboratory. The statistical analyses potentially affected by such contamination (standard plate count, total and fecal coliform, and Pseudomonas) were conducted twice, therefore; once including these suspect values, and once deleting them from the analysis. In no case did removal of the inferred contaminated samples change the significance or nonsignificance of the test statistic employed. The probability levels reported in the following paragraphs are those from the analyses excluding the possibly contaminated values. All tests of the null hypothesis of no difference were evaluated with two-sided levels of significance, in order to allow for possibly significant differences in an unpredicted direction.

Source and distance analyses were performed only on those microbiological parameters which were detected in sufficient quantity to warrant statistical treatment. Four parameters met this criterion: standard plate count, total coliform, fecal coliform and Pseudomonas. The results of these analyses conducted are summarized in Table 23, and a more detailed discussion follows in the text.

The Period 4 and 5 high volume aerosol sampler data were combined, and comparisons were made of the upwind and closest downwind samples. A paired sample t-test performed on natural log transformed standard plate count data from the high volume samplers revealed that the close downwind samples had significantly higher counts ($p = .025$). A similar test performed on natural log transformed Andersen sampler data from Period 4 also found significantly higher levels in the close downwind samples ($p = .008$). This implicates the Egan sewage treatment plant as a source of bacterial aerosol as measured by the standard plate count. However, further comparisons of natural log transformed upwind levels versus residential downwind levels showed there to be no significant differences between them. This was true for both the high volume and the Andersen sampler data.

TABLE 23. SUMMARY OF SOURCE AND DISTANCE ANALYSES PERFORMED ON PERIOD 4 AND 5 AIR SAMPLE MICROBIOLOGICAL DATA

Microbiological Parameter	Local Source Analysis	Residential Distance Analysis
Standard Plate Count		
High Volume Samplers	Significant source, P = 0.025	No effect at residential distances
Andersen Samplers*	Significant source, P = 0.008	No effect at residential distances
Total Coliform	Significant source, P< 0.001	No effect at residential distances
Fecal Coliform	Significant source, P = 0.01	No effect at residential distances
Pseudomonas	Not significant source	

*Period 4 data only.

Similar paired sample t-tests were performed on the natural log transformed period 4 and 5 total coliform concentrations. The comparison of upwind versus closest downwind levels revealed a highly significant t-value ($p < .001$), suggesting that the sewage treatment plant was a source of total coliform. However, just as for the standard plate count data, no significant difference was found between upwind concentrations and residential downwind levels.

Because a great number of fecal coliform concentrations were close to, or below, the detection level, a t-test was inappropriate. Therefore, a Wilcoxon signed ranks test was performed on natural log transformed Period 4 and 5 data. This test yielded a significant rank sum ($p = .01$) for the comparison of upwind level versus closest downwind level, implicating the plant as a source of this microbiological indicator. No significant difference was found between upwind fecal coliform levels and residential downwind levels.

Of the various other microbiological parameters subjected to laboratory analyses in the Period 5 high volume air samples, only Pseudomonas was detected in enough quantity to warrant statistical analysis. A signed rank test of the natural log transformed concentrations for upwind samples versus closest downwind samples showed that the close downwind levels were not significantly greater than the upwind levels. This suggests that the sewage treatment plant is not a significant source of Pseudomonas.

Microbiological Sampling Variability--It was possible to obtain a measure of the variation in measured microbiological aerosol concentrations between samplers from two high volume sampling runs in Period 5, during which two air samples were taken simultaneously at the same distance with different samplers placed side by side. A coefficient of variation was determined for both runs for each of four microbiological parameters: standard plate count, total coliform, fecal coliform, and Pseudomonas. The two coefficients were then averaged for each parameter; this procedure yielded an average variation coefficient of 0.76 for standard plate count, 0.93 for total coliform, 0.38 for fecal coliform, and 0.58 for Pseudomonas. With such a limited amount of data, these sampling variability estimates are subject to much uncertainty.

More precise measures of the between sampler variation for high volume air samplers have been obtained from SwRI's environmental monitoring study of spray irrigation aerosols at Pleasanton, California(44). This study has included eight special quality assurance runs in each of which eight or more high volume air samplers (the same samplers and operators used in Period 5 at the Egan plant) were placed side by side at the same distance from the line of sprayers. The between sampler coefficients of variation at Pleasanton have averaged 0.45 for standard plate count, 0.35 for total coliform, 0.39 for fecal coliform, 0.64 for coliphage, 0.40 for Pseudomonas, and 0.61 for fecal Streptococci, excluding the values inferred to have been affected by sample contamination.

A comparison was made of the sampler variability estimates given above with the variability in the paired upwind vs. downwind comparisons of the source and distance analysis. Only the standard plate count and total coliform parameter data were sufficiently quantitative to warrant this comparison. For both papameters, the standard deviations of the paired comparisons of upwind with both close and residential downwind distances were an order of magnitude higher than the between sampler standard deviations. These large paired comparison deviations are probably due to large local differences in the background levels of standard plate count and total coliform at the upwind and downwind locations that were sampled simultaneously. Considering these large local differences and the relatively small number of sampling runs conducted, it is very unlikely that small true differences between the upwind and downwind levels of any sampled parameter (i.e., differences of the same order of magnitude as the upwind levels) that might be produced by the Egan plant could be statistically detected from the air sampling data. Therefore, negative findings in the source and distance analysis (i.e., that the Egan plant is not a significant source or has no effect at residential distances) indicate only that the Egan plant does not make the predominant contribution to the downwind levels.

Model of Human Microbiological Aerosol Exposure--It has been our intent to develop a limited model of likely human exposure to microbiological aerosols emanating from a sewage treatment plant, including consideration of source variation, diffusion factors, aerosolization factors, and factors causing microbiological die-off both in the initial shock of aerosolization and subsequently with aerosol age. The microbiological aerosol concentration data obtained on this study are inadequate to warrant mathematical model development. However, our Pleasanton spray irrigation study[44] has provided a much more complete microbiological aerosol concentration data base under a variety of meteorological conditions, from which a valid microbiological aerosol exposure model may be developed.

Our Pleasanton results do indicate that long-term cumulative microbiological aerosol exposure detectable through clinical specimen microbiology and disease and symptom incidence should show a negative exponential decrease with distance from the source. Because of the cyclical wind direction pattern associated with frontal passage in a continental climate, the direction of a residence from the Egan plant should have much less effect on long-term exposure than does its distance. While short-term exposure depends strongly on solar radiation and other meteorological factors, long-term cumulative exposure is less influenced by meteorological factors because it integrates over the daily cycle in these factors. Therefore, the negative exponential of distance from the Egan plant can be considered as a prime surrogate measure of long-term cumulative exposure to its microbiological aerosol.

Trace Metals--

Trace Metal Concentration Data--The trace metal concentrations obtained from the particulate air samples taken in Periods 1, 2, 4, and 5 are presented in Tables 24 and 25. Table 24 reports the concentrations from Periods 1 and 2, before the sewage treatment plant was in operation. These samples were taken at sites approximating the locations of the operational period samples, to get baseline levels of the trace metals to be measured. The baseline levels are fairly uniform across the various locations, with considerable variability among samples.

Table 25 reports the trace metal concentrations for the Periods 4 and 5 particulate air samples. The concentrations have been categorized into three general sampling areas (residential upwind, sewage treatment plant, and residential downwind) and the arithmetic and geometric means and the standard deviations calculated for each group. The samples taken within a 300 meter radius of the first stage aeration basin do not seem to have noticeably higher concentrations of cadmium or lead, suggesting that the plant makes a negligible contribution to the levels of these metals in the air. Figures 13 and 14 plot the cadmium and lead concentrations for each day's samples with distance for Periods 4 and 5. Each day's samples have been connected with solid lines and the day has been enumerated at both ends of each daily line. The high upwind lead concentrations on days 6 and 7 of Period 5 were sampled just downwind of a 30-35,000 car per day highway. These figures confirm that the cadmium and lead concentrations show no consistent pattern of increase or decrease with distance.

The mercury concentrations do seem to have most of their highest values in the vicinity of the sewage treatment plant. The operational period values are also generally higher in all three locations than those obtained in the April 1975 sampling (Table 24). The Period 4 levels tend to be higher than those in Period 5. The off-scale results, which exceeded the upper detection limit, have not been included in calculating the means and standard deviations. These off-scale results could be due either to valid high values or to sample contamination.

Figure 15 shows the mercury concentrations plotted against distance. The Period 4 data were plotted twice, because of the presence of off-scale values in the samples collected at the aeration basin. In the upper graph, the off-scale values are plotted at an arbitrary cut-off point; in the lower graph, they have been deleted. The final graph shows the Period 5 mercury concentrations plotted against distance. These three plots, when considered together, seem to provide some evidence that the mercury levels are elevated within the plant boundaries.

Trace Metal Source and Distance Analysis--The statistical analysis of the trace metal concentrations found in the particulate air sampling was similar to that of the microbiological concentrations. Similar questions

TABLE 24. TRACE METAL CONCENTRATIONS IN PERIODS 1 AND 2 PARTICULATE AIR SAMPLES

	Trace Metal Concentrations (µg/m³)												Mercury Concentrations (µg/m³)		
	Period 1						Period 2						April, 1975		
Location	Date	Distance (meters)	Cadmium	Copper	Lead	Zinc	Date	Distance (meters)	Cadmium	Copper	Lead	Zinc	Date	Distance (meters)	Mercury
Residential Upwind (>300 m)	10-13-74	1600 U	0.0024	0.100	0.60	0.347	1-27-75	1600 U	0.0028	0.132	1.01	0.382	4-17-75	1300 U	0.0028
	10-14-74	5000 U	0.0031	0.099	0.33	<0.025	1-27-75	500 U	0.0023	0.041	0.74	0.197	4-23-75	800 U	0.0118
	10-15-74	1600 U	0.0014	0.121	0.95	0.185	1-28-75	500 U	0.0028	0.047	0.97	0.312	4-23-75	1300 U	0.0066
	10-16-74	5000 U	0.0013	0.058	0.46	0.185	1-29-75	500 U	0.0043	0.263	0.45	0.049	4-23-75	1300 U	0.0049
	10-16-74	1600 U	0.0013	0.069	0.29	0.185							4-23-75	800 U	0.0094
	10-17-74	5000 U	0.0011	0.108	0.38	0.031							4-24-75	1600 U	0.0119
	10-17-74	1600 U	0.0024	0.083	0.32	0.127							4-24-75	1600 U	0.0061
	10-18-74	1600 U	0.0005	0.011	<0.04	0.197									
	10-19-74	1600 U	0.0013	0.186	0.30	0.150									
Geometric Mean			0.0015	0.076	0.30	0.11			0.0030	0.090	0.76	0.18			0.0069
Arithmetic Mean			0.0016	0.093	0.41	0.16			0.0030	0.121	0.79	0.24			0.0076
Standard Deviation			0.0008	0.048	0.26	0.10			0.0009	0.104	0.26	0.15			0.0035
Sewage Treatment Plant (1300 m)	10-13-74	50 D	0.0021	0.086	0.69	0.382	1-26-75	50 D	0.0009	0.099	0.77	0.197	4-14-75	0	0.0085
	10-14-74	50 D	0.0006	0.077	0.48	0.127	1-27-75	50 U	0.0049	0.186	2.13	0.775	4-15-75	0	0.0067
	10-15-74	50 D	0.0018	0.143	2.27	0.116	1-28-75	50 U	0.0029	0.164	1.03	0.347	4-23-75	0	0.0123
	10-16-74	50 D	0.0031	0.076	0.33	0.231	1-29-75	50 U	0.0007	0.132	0.69	0.127	4-23-75	0	*
	10-17-74	50 D	0.0010	0.082	0.51	0.081	1-30-75	5 D	0.0040	0.044	0.38	0.113			
	10-18-74	50 D	0.0005	0.046	0.39	0.047	1-30-75	50 D	0.0010	0.143	0.41	0.104			
	10-19-74	50 D	0.0015	0.068	0.33	0.139	1-31-75	5 D	0.0020	0.019	0.63	0.162			
							1-31-75	50 D	0.0009	0.132	0.91	0.220			
							2-1-75	5 D	0.0016	0.012	0.59	0.025			
							2-1-75	50 U	0.0008	0.107	1.36	0.106			
Geometric Mean			0.0013	0.078	0.56	0.13			0.0016	0.078	0.78	0.15			0.0089
Arithmetic Mean			0.0015	0.082	0.71	0.16			0.0020	0.104	0.89	0.22			0.0072
Standard Deviation			0.0009	0.030	0.70	0.11			0.0015	0.060	0.52	0.21			0.0029
Residential Downwind (>300 m)	10-13-74	500 D	0.0020	0.092	0.42	0.289	1-26-75	500 D	0.0038	0.020	0.83	0.185	4-15-75	2100 D	0.0087
	10-13-74	1600 D	0.0006	0.044	0.25	0.173	1-26-75	1600 D	0.0004	0.056	0.72	0.061	4-15-75	2100 D	0.0103
	10-14-74	1600 D	0.0015	0.175	1.15	0.197	1-26-75	5000 D	0.0012	0.329	0.67	0.231	4-15-75	1300 D	0.0077
	10-14-74	5000 D	0.0014	1.261	1.08	0.220	1-27-75	1600 D	0.0034	0.384	1.56	0.532	4-24-75	800 D	0.0039
	10-15-74	1600 D	0.0015	0.143	1.46	0.208	1-28-75	1600 D	0.0055	0.406	0.93	0.335	4-24-75	800 D	0.0066
	10-16-74	1600 D	0.0011	0.041	0.52	0.324	1-29-75	500 D	0.0034	0.033	0.42	0.053			
	10-17-74	1600 D	0.0005	0.074	2.59	0.097	1-29-75	1600 D	0.0024	0.105	0.37	<0.025			
	10-18-74	1600 D	0.0026	0.084	0.51	0.139	1-30-75	500 D	0.0035	0.329	0.29	0.062			
	10-18-74	5000 D	0.0015	0.154	0.71	0.231	1-30-75	1600 D	0.0015	0.026	0.32	0.094			
	10-19-74	1600 D	0.0027	0.132	0.26	0.127	1-31-75	500 D	0.0009	0.274	0.61	0.112			
	10-19-74	5000 D	0.0011	0.252	0.37	0.108	1-31-75	1600 D	0.0018	0.020	0.53	0.113			
							2-1-75	5000 D	0.0009	0.461	0.59	0.088			
Geometric Mean			0.0013	0.169	0.68	0.18			0.0019	0.113	0.55	0.10			0.0071
Arithmetic Mean			0.0015	0.296	0.92	0.19			0.0024	0.203	0.62	0.19			0.0074
Standard Deviation			0.0007	0.390	0.76	0.07			0.0015	0.175	0.36	0.15			0.0024
Detection Limit:			0.0003	0.0043	0.0448	0.0248			0.0003	0.0043	0.0448	0.0248			0.0024

* Sample tube broken

TABLE 25. TRACE METAL CONCENTRATIONS IN PERIODS 4 AND 5 PARTICULATE AIR SAMPLES

Trace Metal Concentrations µg/m³

	Period 4					Period 5				
Location	**Date**	**Distance (meters)**	**Cadmium**	**Lead**	**Mercury**	**Date**	**Distance (Meters)**	**Cadmium**	**Lead**	**Mercury**
Residential	2-9-76	1600 U	0.0011	0.29	*	9-30-76	800 U	0.0019	0.13	0.044
Upwind	2-11-76	500 U	0.0008	0.27	0.022	10-1-76	800 U	0.0037	3.23	0.025
(>300m)	2-12-76	3000 U	0.0013	0.11	0.016	10-4-76	1300 U	0.0011	0.61	0.005
	2-13-76	500 U	0.0055	2.08	0.034	10-6-76	2200 U	0.0007	2.32	*
	2-14-76	3300 U	0.0017	0.79	0.082	10-7-76	2200 U	0.0008	4.73	0.002
	2-15-76	500 U	0.0008	0.76	0.045					
Geometric Mean			0.0014	0.47	0.034			0.0013	1.23	0.010
Arithmetic Mean			0.0019	0.72	0.040			0.0016	2.20	0.019
Standard Deviation			0.0018	0.72	0.026			0.0012	1.89	0.020
Sewage	2-9-76	240 D	0.0018	0.11	*	9-30-76	0	0.0018	1.39	0.104
Treatment	2-9-76	1 D	0.0009	0.09	*	9-30-76	150 D	0.0010	0.70	0.048
Plant	2-9-76	125 D	0.0008	0.11	0.077	10-1-76	0	0.0010	3.71	0.013
(≤300m)	2-10-76	1 D	0.0013	0.24	†	10-1-76	162 D	0.0015	3.68	0.021
	2-10-76	230 D	0.0012	0.21	0.024	10-2-76	0	0.0030	2.51	0.058
	2-11-76	100 D	0.0011	0.11	0.026	10-2-76	162 U	0.0021	1.81	0.018
	2-11-76	100 D	0.0005	0.07	**	10-3-76	0	0.0013	1.23	0.017
	2-11-76	1 D	0.0009	0.17	†	10-3-76	162 U	0.0011	1.11	0.016
	2-12-76	150 D	0.0017	0.15	0.011	10-3-76	150 D	0.0011	0.72	0.042
	2-12-76	190 D	0.0011	0.43	0.036	10-4-76	0	△	△	0.006
	2-12-76	1 D	0.0012	0.19	†	10-6-76	0	0.0004	0.13	0.003
	2-13-76	150 D	0.0046	1.64	0.012	10-6-76	210 D	0.0009	0.22	††
	2-13-76	1 D	0.0043	1.75	0.215	10-7-76	0	0.0006	0.55	0.003
	2-14-76	1 D	0.0020	0.55	**	10-7-76	150 D	0.0011	0.56	<0.001
	2-15-76	190 D	0.0006	0.59	0.113					
	2-15-76	1 D	0.0064	0.87	**					
	2-15-76	230 D	0.0003	0.59	**					
	2-15-76	230 D	0.0021	1.11	**					
	2-16-76	100 D	0.0014	0.59	0.063					
	2-16-76	100 D	0.0045	0.98	0.016					
Geometric Mean			0.0014	0.33	0.038			0.0012	0.95	0.014
Arithmetic Mean			0.0019	0.53	0.059			0.0013	1.41	0.027
Standard Deviation			0.0017	0.51	0.064			0.0007	1.21	0.029
esidential	2-10-76	1300 D	0.0009	0.12	0.016	10-1-76	420 D	0.0015	0.72	0.044
ownwind	2-11-76	2100 D	0.0008	0.40	0.008	10-2-76	1300 D	0.0033	1.47	0.015
(>300m)	2-13-76	3300 D	0.0027	1.92	0.015	10-2-76	3100 D	0.0050	1.75	0.021
	2-14-76	500 D	0.0016	0.55	0.009	10-3-76	3100 D	0.0015	0.86	0.007
	2-14-76	750 D	0.0011	0.73	0.014	10-3-76	1300 D	0.0024	0.65	*
	2-15-76	1300 D	0.0011	0.67	0.011	10-4-76	2200 D	0.0014	0.24	0.005
	2-15-76	3300 D	0.0014	0.78	†	10-4-76	840 D	0.0021	0.15	0.020
						10-6-76	1300 D	0.0008	0.26	0.019
						10-6-76	3300 D	0.0005	0.30	0.006
						10-7-76	540 D	0.0031	0.85	0.002
						10-7-76	4400 D	0.0011	1.17	0.036
Geometric Mean			0.0013	0.57	0.0118			0.0017	0.59	0.010
Arithmetic Mean			0.0014	0.74	0.0122			0.0021	0.77	0.017
Standard Deviation			0.0007	0.57	0.0033			0.0013	0.53	0.014
Detection Limit:			0.0003	0.04	0.002			0.0003	0.04	0.002

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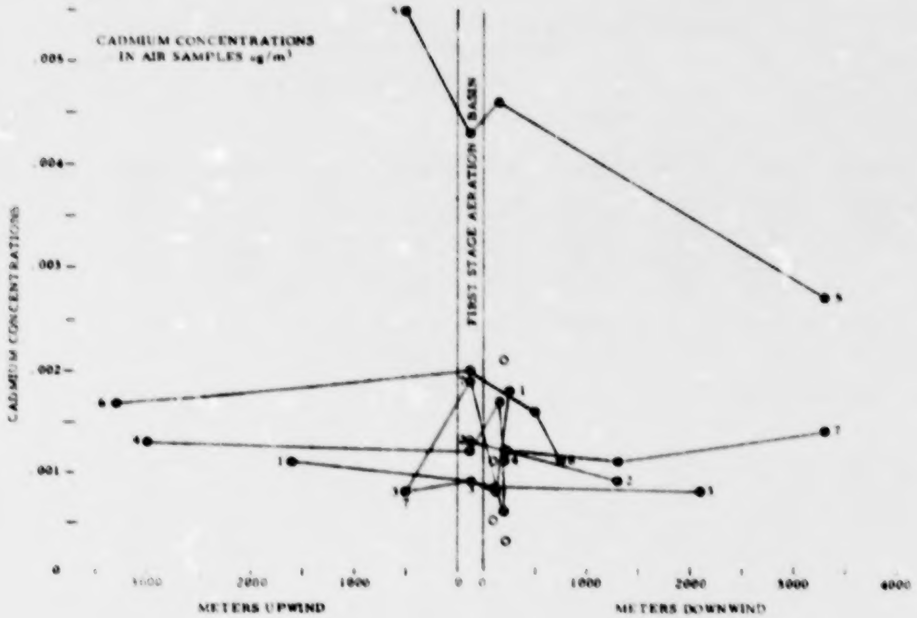
* Sample lost in shipment
† Off scale
** No sample taken
†† Tube broken in shipment
△ Equipment failure

PERIOD 4 CONCENTRATIONS



PERIOD 5 CONCENTRATIONS

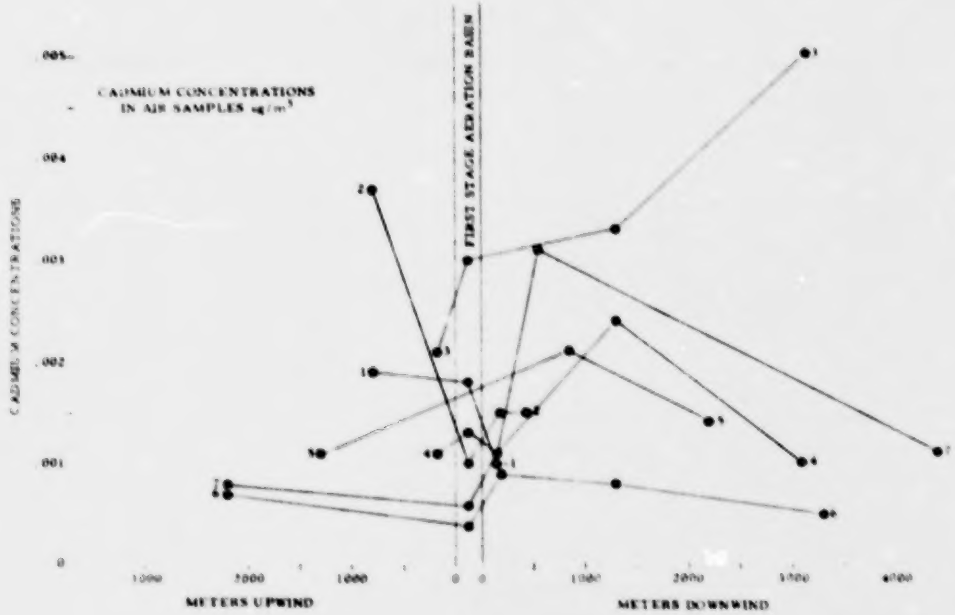
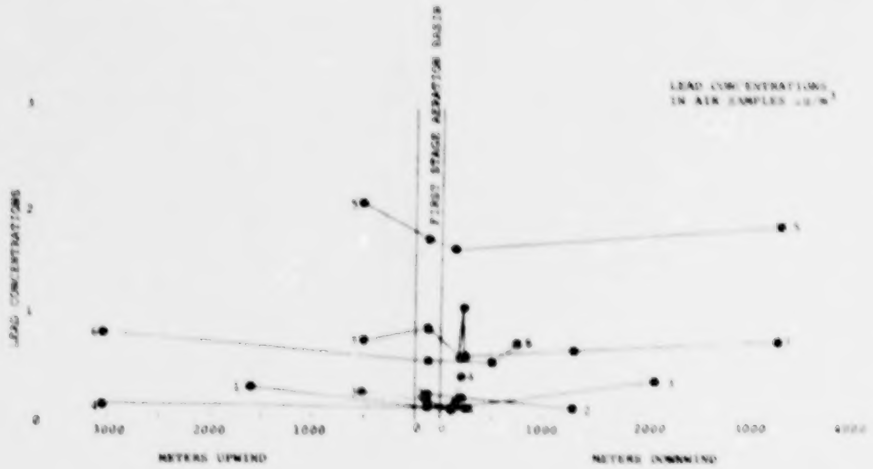


Figure 13. Cadmium concentrations plotted by distance.

PERIOD 4 CONCENTRATIONS



PERIOD 5 CONCENTRATIONS

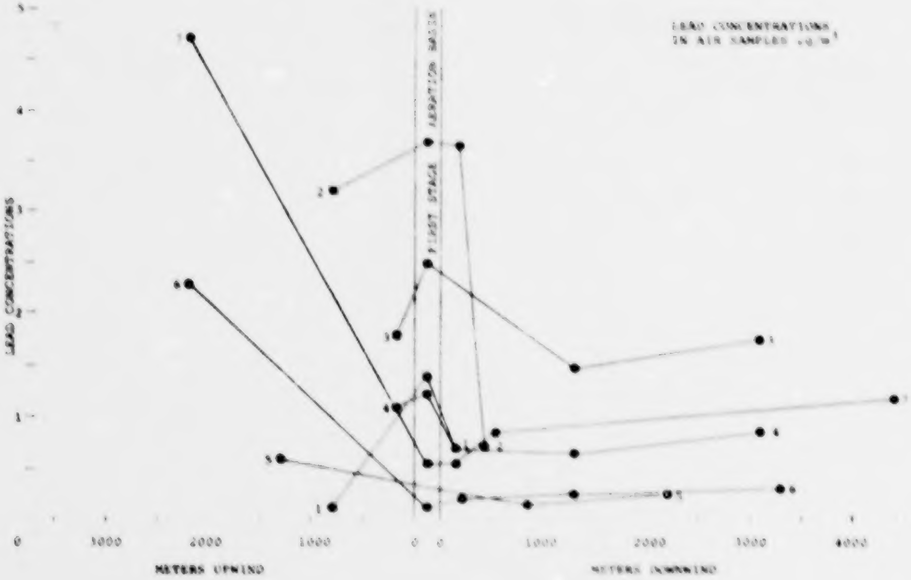
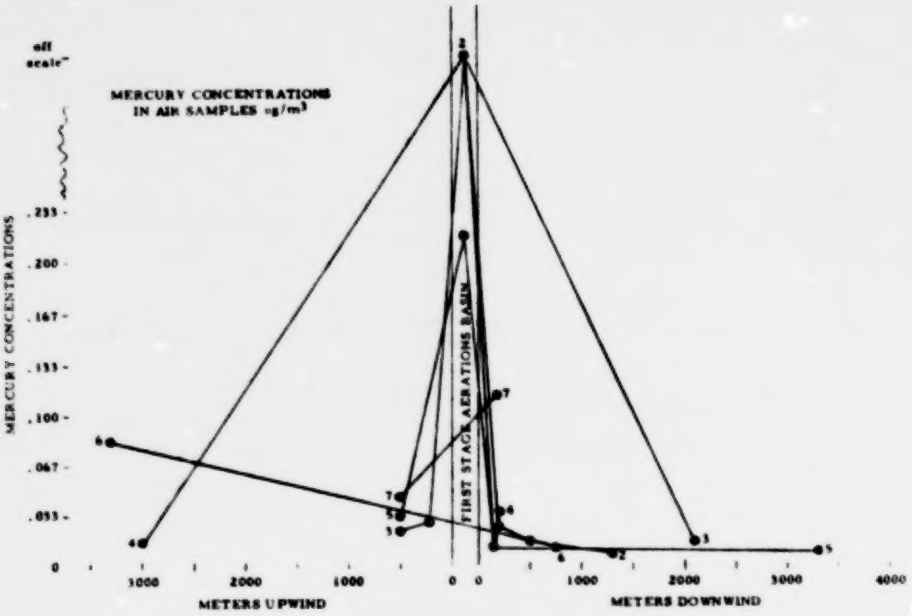
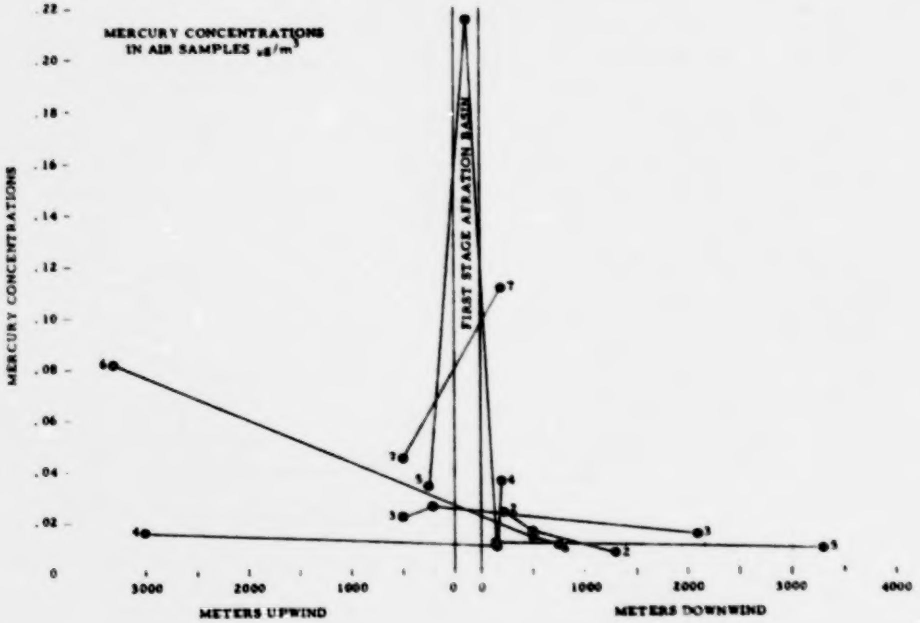


Figure 14. Lead concentrations plotted by distance.



PERIOD 1 CONCENTRATIONS; ALL DATA



PERIOD 4 CONCENTRATIONS; OFF SCALE VALUES EXCLUDED

(continued)

Figure 15. Mercury concentrations plotted by distance.

PERIOD 5 CONCENTRATIONS

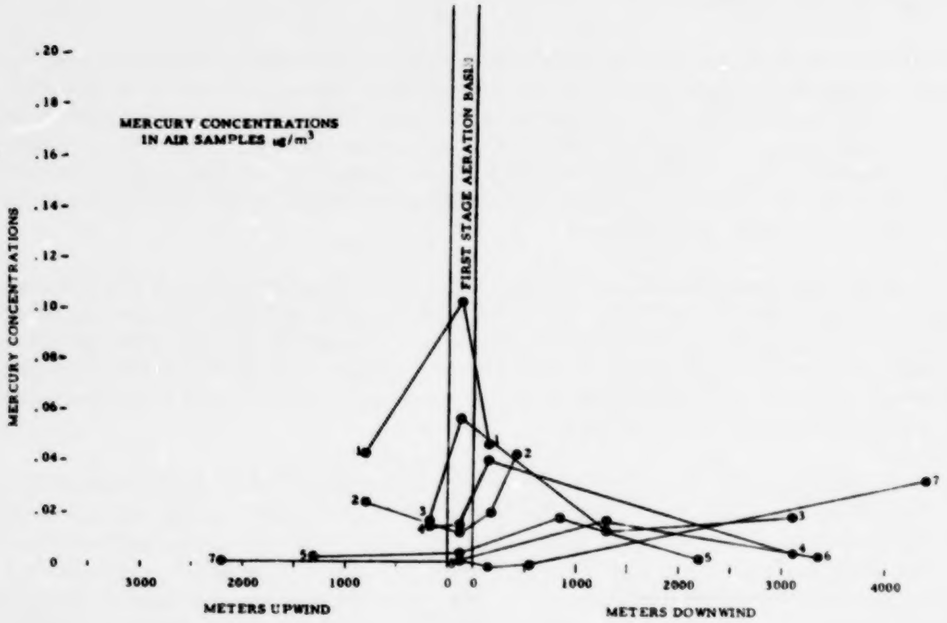


Figure 15. (continued).

concerning the sewage treatment plant as a possible local source of aerosolized metal and a potential health hazard in the residential downwind areas were considered through paired comparison procedures. The cadmium, lead, and mercury concentrations from Periods 4 and 5 were combined to increase the sample sizes. The samples taken each day were obtained over approximately the same 24-hour periods, so the samples taken at various distances from the plant were paired according to day.

No actual statistical test was performed on the cadmium data, as preliminary inspection of the means for residential upwind, sewage treatment plant, and residential downwind samples, and of the plots of cadmium concentrations with distance clearly indicated that there were no differences between the concentrations obtained from these three general areas.

Initial inspection of the mean concentrations of lead suggested that the upwind residential concentrations might generally be greater than the closest downwind concentrations. This suggests that other local sources of aerosolized lead, such as automotive exhaust near expressways and highways, predominate over the sewage treatment plant contribution to aerosol lead levels. A paired-sample t-test was conducted, comparing the natural log transformed lead concentrations upwind (at least 300 meters from the plant) and the closest downwind concentrations for each day. This test found no significant difference between the concentrations obtained upwind and at the sewage treatment plant.

Because many of the air samples taken at the closest downwind distances had missing or off-scale mercury concentrations (see footnotes to Table 25), a geometric mean of all downwind samples taken at a distance of no more than 300 meters was used as a comparison value against the upwind sample concentrations for each day. A t-test was employed to test the differences between these paired samples; the resulting t-value reached only borderline significance levels ($p = .065$), although it would have reached significance if a one-sided test of significance had been employed.

Because it seemed likely that the off-scale values reported at distances of 1 meter downwind (actually above the center of the first stage aeration basin) in Period 4 were true measures of the mercury concentrations at that location, a sign test was also applied to the differences between upwind and aeration basin samples, with these off-scale values included. This test yielded the same result as had the t-test, indicating no difference at a two-sided .05 level of significance ($p = .07$). These two statistical tests suggest that no strong inferences should be drawn concerning the sewage treatment plant as a source of aerosolized mercury without obtaining additional confirming data. A comparison of the residential upwind concentrations against the residential downwind levels (using the geometric mean of all samples taken beyond 300 meters on a given day) was not significant. Thus, if the plant is indeed a source of mercury in the air, its contribution is not detectable in downwind residential areas.

Trace Metal Sampling Variability--As with the microbiological aerosol sampling, a measure of trace metal sampler variability was available from two samples taken on the same day and at the same distance. The average coefficients of variation obtained were 0.88 for cadmium, 0.39 for lead, and 0.84 for mercury. Since these coefficients are based on extremely limited data, they are imprecise measures of sampling variation. Ten sets of duplicate aerosol lead data were taken using the same samplers on a neighborhood lead study.(46) This data yielded an average coefficient of variation of 0.092 for lead sampling variability.

As with the microbiological air data, the trace metal sampler variability, large location variability, and small sample sizes suggest that negative source and distance findings about trace metals indicate only that the Egan plant does not make a predominant contribution to the downwind levels of the trace metals.

Soil Samples

Samples from the fifty sites were taken in each of the four periods for microbiological and trace metal analyses. The microbiological analyses sought pathogenic bacteria and enteric viruses but also included standard plate count and such sewage indicators as coliforms and fecal streptococci. Trace metal concentrations were obtained for lead, copper, cadmium, zinc, and mercury. The results of these investigations were submitted to statistical analysis according to the appropriate methods as outlined in the following methods section, and the results and inferences drawn are presented below.

Statistical Methods–

The data from the microbiological and trace metal analyses are in the form of a matrix of four periods and 50 sampling sites, for a total of 200 observations. The purposes of the statistical analysis were to determine the effects of the plant's operation through terms of pre-operational (Periods 1 and 2) vs. post-operational (Periods 4 and 5) comparisons and to establish whether operational period increases have a distance relationship. To accomplish this, a two-way analysis of variance (ANOVA) was used, with factors of periods and sites. A no-interaction or additive model was selected, since no replications of the analyses were made and there is thus no independent source of sampling error. The interaction between periods and sites is assumed to be negligible so the residual sum of squares can be attributed to sampling error and used to calculate the F- ratios for significance testing.

The method of orthogonal contrasts has been used to test the hypotheses concerning plant and distance effects. When a prior F-test indicated that the periods factor was significant for a data set, two hypotheses have been tested. The first investigated the pre-operational vs. post-operational levels of the variable, and the second compared seasons for the operational Periods 4 (February 1976) and 5 (October 1976). The null hypotheses may be stated as:

$$Ho_1 : \mu_1 + \mu_2 - \mu_4 - \mu_5 = 0$$
$$Ho_2 : \mu_4 - \mu_5 = 0$$

To partition the periods sum of squares using this method requires that the contrasts be mutually orthogonal, which is easily verified in this case. Each sum of squares calculated for a contrast has one degree of freedom associated with it and the test of significance was made using an F-ratio, comparing the mean square for the contrast to the error mean square.

Similarly, if there was a significant sites factor, a contrast was used to test for the effect of closeness to the plant. Sites falling within or near the 500-meter radius around the plant are considered "near" for the purposes of this analysis and the remainder are classified as "far." There are 18 near sites and 32 far ones. This hypothesis may be stated as:

$$Ho_3: 16(\Sigma\mu_N) - 9(\Sigma\mu_F) = 0$$

Where

$\Sigma\mu_N$ - sum of the "near" means

$\Sigma\mu_F$ - sum of the "far" means

and 16 and 9 have been selected so the sum of the coefficient equals zero, as required for a contrast. This contrast was also tested for significance using an F-ratio of the mean squares for the contrast and for error.

A possible effect resulting from the treatment plant operation was considered to be indicated when there was a significant difference in the period terms, substantiated by the pre- vs. post-operational period contrasts, and when the concentration pattern with distance of the site from the plant was consistent with the plant being a significant source.

Microbiological–

In all four periods, every soil sample analysis for pathogenic bacteria, enteric viruses, coliforms, and fecal Streptococci was negative. All pathogenic bacteria were searched for, including Klebsiella pneumoniae, Proteus, Pseudomonas, Salmonella, Shigella, Staphylococcus aureus, and streptococcus-beta. As a result, the only microbiological data available to evaluate the sewage treatment plant were the standard plate counts. They are presented in Table 26 for the four periods under study.

TABLE 26. STANDARD PLATE COUNT FOR SOIL SAMPLES

(no./ml × 10^6)

Site	Period			
	1	2	4	5
1	98	160	3.3	80
2	280	8.5	1.6	200
3	20	17	120	620
4	190	8.1	27	4600
5	740	1.7	17	50
6	47	26	20	30
7	150	52	140	100
8	2.3	64	10	90
9	14	290	8.6	130
10	10	230	50	60
11	79	8.8	4.5	40
12	69	5.5	22	90
13	2.7	3.4	0.15	6.3
14	50	24	7.1	8.4
15	310	6.6	11	6.1
16	270	4.5	50	6.0
17	420	3.4	3.6	0.15
18	850	13	9.4	22
19	52	3.7	0.47	20
20	220	67	4.6	8.0
21	71	20	5.3	9.1
22	41	3.8	2.9	14
23	49	12	13	6.8
24	50	0.2	6.0	1.8
25	80	8.0	2.1	5.8
26	290	14	3.0	13
27	470	30	18	6.4
28	110	12	2.8	7.2
29	1.0	14	2.8	12
30	8.9	7.0	2.3	3.1
31	6.0	8100	1.5	7.7
32	140	86	6.1	6.4
33	35	8700	4.0	6.3
34	490	910	3.2	5.4
35	62	40	6.7	4.1
36	61	37	0.43	3.0
37	500	32	5.0	21
38	250	19	2.3	6.9
39	540	18	1.1	3.4
40	360	10	4.7	30
41	290	7.5	0.89	2.6
42	57	8.9	1.5	10
43	15	1.8	4.4	0.70
44	48	7.1	4.0	5.5
45	41	11	8.8	1.1
46	42	720	4.1	3.6
47	270	8.3	3.2	9.3
48	0.70	1.7	3.3	7.8
49	5.3	3.9	6.6	0.096
50	150	6.7	2.0	2.6

As can be seen, the results were quite variable, and those from Period 1 were higher than those of succeeding periods by one to two orders of magnitude. On the basis of the observed counts and on previous experience with microbiological data, it was decided to use a logarithmic transformation (ln x) prior to conducting the ANOVA on the data. The results of the ANOVA are contained in Table 27.

TABLE 27. ANOVA ON STANDARD PLATE COUNT IN SOIL SAMPLES

(ln X)

Source	df	SS	MS	F	Significance Level
Periods	3	177.81	59.27	22.03	<0.01
1, 2 vs 4, 5	1	122.46	122.46	45.52	<0.01
4 vs 5	1	15.21	15.21	5.65	<0.01
Sites	49	192.73	3.93	1.46	0.05
Near vs Far	1	2.85	2.85	1.06	N.S.
Period X Site (error)	147	394.82	2.69		
Total	199	765.36			

Period Means (ln X)

1	2	4	5
4.20	2.93	1.61	2.39

Site Means (ln X)

Near	Far
2.74	2.81

The periods factor is significant beyond the 1-percent level, which means that some changes did occur in the observed levels from period to period. The period means as shown in the table indicate that the highest levels were in Period 1 while the lowest occurred in Period 4, the same season of the year two years later. The contrasts of interest with respect to periods were tested and both the pre- vs.post-operational contrast and the Period 4 vs. Period 5 contrast were significant beyond the 1-percent level.

The pre-post comparison indicates that there was a change, and that the overall levels decreased significantly. The comparison of Periods 4 and 5, however, gives a significant increase for the October sampling period. The geometric means are 5.0×10^6, and 10.9×10^6 respectively, or a factor of two between the two periods.

The sites factor was also significant, and the contrast of near sites vs. far sites is tested for the plate count data. The criterion for a near site is one within a 500-m radius from the center of the first stage aeration basin. The F-ratio for this test is not significant at the 10-percent level and thus no effect related to distance from the plant can be observed.

The interaction sum of squares is used to represent the sampling error term, under the assumption that no interactive effect is present. For these data, presence of an interaction would indicate that some stations increased while others decreased in significant amounts from one sampling period to another, rather than a general trend up or down for an entire sampling period. In this ANOVA, the magnitude of the error mean square is small enough to imply that no interactive effect was present which might have unduly influenced the results.

Thus, a decrease in standard plate count was observed in the post-operational periods versus the pre-operational, and an increase occurred from Period 4 to Period 5. However, the sites comparison did not indicate that those sites close to the plant were higher or lower on average than those some distance away from the plant. As a result, no influence of the plant on these period-to-period changes in the observed standard plate count can be detected, and they are attributed instead to other factors.

Trace Metals–

The soil samples were analyzed for five trace metals— lead, copper, cadmium, zinc and mercury—during periods 1, 2, 4 and 5. The results from these analyses are used in the ANOVA model described in the preceding Statistical Methods section to determine if any increase in the environmental levels of these metals occurred subsequent to the plant beginning operation and, if so, whether these changes could be related to closeness to the plant. Fifty sites were used to collect samples during each period, and the analyses were completed for all metals except for zinc in Period 5.

The ANOVA model requires homogeneous variance among the factors, so a preliminary investigation was made into the error terms. Using the variability among sites within a given period as the standard, standard deviations were calculated and used to calculate Bartlett's test statistics for each metal. Comparing these statistics to a chi-square distribution gives the significance levels shown in Table 28. To achieve homogeneity, the results were transformed using a natural logarithmic transformation. For those metals which had values between 0 and 1, a constant of 1 was added to the value prior to taking the logarithmic transformation. This results in only positive values being used and reduces the overall variability. The standard deviations and Bartlett's statistics are presented for these transformed data as well.

As can be seen, for none of the metals could the variances be considered homogeneous for the nontransformed data. Under the transformation, however, all but the Hg and Cd data achieved homogeneity, and the ANOVA is conducted on all metals under the transformation. The rationale behind this is that the transformed values showed a greater agreement than the nontransformed, that the magnitude of the difference between the one high value and the remainder is small, and that this provides greater consistency in the results presented. Since the significance level of the F-ratio is affected by violating this assumption, caution is then exercised in interpreting the results of any significant factors in the mercury or cadmium analyses. The results of the ANOVA's and subsequent contrasts of sub-hypotheses, if any, are presented below for each metal under study.

TABLE 28. EQUALITY OF VARIANCE TESTS–ORDINARY VS TRANSFORMED

Metal	Period	Ordinary			Transformed*		
		Std Dev	Test Statistic	Significance Level	Std Dev	Test Statistic	Significance Level
Lead	1	14.31			0.60		
	2	15.56			0.81		
	4	37.65			0.62		
	5	68.99	151.24	<0.01	0.71	5.64	N.S.
Copper	1	0.77			0.30		
	2	0.55			0.23		
	4	1.07			0.36		
	5	1.11	27.76	<0.01	0.31	9.50	0.025
Cadmium	1	0.45			0.21		
	2	0.34			0.17		
	4	0.22			0.14		
	5	0.51	34.72	<0.01	0.25	17.98	<0.01
Zinc	1	11.62			0.74		
	2	17.62			0.82		
	4	10.50	15.48	<0.01	0.64	2.96	N.S.
Mercury	1	0.04			0.03		
	2	0.09			0.07		
	4	0.02			0.02		
	5	0.03	133.37	<0.01	0.02	114.27	<0.01

*ln X for zinc, ln (1 + X) for others.

Lead–The analyses for lead content are summarized in Table 29. The ANOVA for the lead results from the four periods is presented in Table 30. As can be seen, the F-ratios for both periods and sites are significant beyond the one-percent level and contrasts were used among the means to determine if relevant differences exist.

For the periods factor, the two contrasts used were those representing a change from the pre-operational to the post-operational period and for contrasting Periods 4 and 5. The sums of squares for the contrasts, each with one degree of freedom, were partitioned out of the total sums of squares for periods and F-ratios were calculated.

There was a significant increase in the soil lead from the pre- to post-operational periods, as can be seen from the F-ratio for that contrast. The significance level of the pre- vs. post-contrast is less than 0.01, and the difference of 0.714 translates into 2.04μg/g increase in the original scale. The Period 4 vs. Period 5 contrast was also significant beyond the 1-percent level, with a calculated difference of 0.463 in the transformed scale. This represents a difference of 1.59 μg/g in the average lead content between these two periods.

To determine if the observed increase could be related to the operation of the plant, the sampling sites were investigated. If the increase in lead results from materials passed through aerosols, then the lead content of the sites close to the plant should be higher than that of the more distant sites. The criterion for near vs. far is selected to be within or near a 500-m radius around the plant. Using this, 18 sites fell into the near and the remaining 32 into the far category. The sums of squares for this contrast was partitioned out of the sites factor and the F-ratio is significant beyond the 1-percent level.

The transformed mean of the 18 near sites is 2.721 vs. 3.057 for the 32 far sites, however, and the far sites had higher average lead content in the soil than the near sites. As a result, there is no indication that the increase is related to the plant.

TABLE 29. DETERMINED CONCENTRATIONS OF LEAD IN SOIL SAMPLES
(μg/gm. dry weight)

Site	Period 1	Period 2	Period 4	Period 5
1	98	160	3.3	80
2	280	8.5	1.6	200
3	20	17	120	620
4	190	8.1	27	4600
5	740	1.7	17	50
6	47	26	20	30
7	150	52	140	100
8	2.3	64	10	90
9	14	290	8.6	130
10	10	230	50	60
11	79	8.8	4.5	40
12	69	5.5	22	90
13	2.7	3.4	0.15	6.3
14	50	24	7.1	8.4
15	310	6.6	11	6.1
16	270	4.5	50	6.0
17	420	3.4	3.6	0.15
18	890	13	9.4	22
19	52	3.7	0.47	20
20	220	67	4.6	8.0
21	71	20	5.3	9.1
22	41	3.8	2.9	14
23	49	12	13	6.8
24	50	0.2	6.0	1.8
25	80	8.0	2.1	5.8

Site	Period 1	Period 2	Period 4	Period 5
26	33.40	36.36	38.27	123.82
27	69.05	78.63	47.34	88.94
28	10.35	4.04	15.55	52.45
29	14.75	6.33	13.46	21.10
30	31.29	65.89	23.92	57.31
31	12.61	13.35	12.89	17.58
32	12.87	13.98	11.43	19.86
33	20.63	20.86	20.50	55.70
34	17.02	61.95	39.85	50.02
35	10.93	17.94	24.91	21.50
36	13.52	18.57	14.94	18.72
37	9.00	9.39	13.48	17.42
38	29.05	27.54	17.28	26.53
39	33.61	29.83	49.80	19.37
40	7.37	1.70	9.96	13.02
41	10.38	7.77	11.00	13.82
42	19.19	14.91	44.86	18.38
43	17.48	10.92	15.05	17.88
44	12.68	8.61	11.86	13.65
45	11.68	7.98	10.42	14.47
46	14.12	7.98	13.60	56.50
47	13.30	15.13	21.41	21.30
48	20.44	14.49	14.18	15.77
49	26.22	23.31	14.76	20.[illegible]
50	16.03	13.23	10.42	18.53

TABLE 30. ANOVA ON LEAD IN SOIL SAMPLES
(ln X)

Source	df	SS	MS	F	Significance Level
Periods	3	12.3933	4.1311	23.69	<0.01
1, 2 vs 4, 5	1	6.3725	6.3725	36.54	< 0.01
4 vs 5	1	5.3592	5.3592	30.73	<0.01
Sites		67.7352	1.3824	7.93	<0.01
Near vs Far	1	2.85	2.85	16.34	<0.01
Period X Site (error)	1	25.6417	0.1744		
Total	199	105.7702			

Period Means (ln X)

1	2	4	5
2.839	2.676	2.883	3.346

Site Means (ln X)

Near	Far
2.721	3.057

Since there is no replication term in these data, the period-by-site interaction is assumed to be zero and used as the error term. If the assumption were not correct, there could be an increase in the near sites not accountable for by the increase over periods and not observed at the far sites. If this were so, one would expect a relatively large mean square for this interaction term. However, the mean square is of relatively low magnitude in this ANOVA, and there is no indication of an unaccounted for interaction in these data. Thus, the increase in soil lead content is not attributed to the operation of the treatment plant.

Copper–The analytical results for copper are shown in Table 31, and the results of the ANOVA on these data are contained in Table 32. The F-ratio for periods was insignificant at all normal criteria, with an estimated significance level of 20-25 percent. The sites factor was significant beyond the one-percent level.

TABLE 31. DETERMINED CONCENTRATIONS OF COPPER
IN SOIL SAMPLES
(μg/gm, dry weight)

Site	Period			
	1	2	4	5
1	0.50	0.56	3.89	0.76
2	1.63	1.52	1.00	1.32
3	1.63	1.29	3.06	1.40
4	1.22	1.07	2.22	1.32
5	1.19	0.97	0.59	1.18
6	0.93	0.92	0.87	0.82
7	0.97	0.86	0.72	0.97
8	0.81	0.79	0.93	0.97
9	0.73	0.97	0.46	1.40
10	0.44	0.97	0.46	0.39
11	0.86	1.09	0.59	1.08
12	0.73	0.87	0.43	1.01
13	1.52	1.72	3.14	1.57
14	0.41	0.46	0.59	0.80
15	0.92	1.77	0.87	1.63
16	1.36	2.27	1.38	1.22
17	4.44	4.09	1.97	8.67
18	0.82	0.78	0.74	1.36
19	0.43	0.50	0.43	0.87
20	0.41	0.50	0.28	0.52
21	0.47	0.55	0.41	0.67
22	0.51	0.53	0.42	0.67
23	3.66	1.87	0.84	2.08
24	3.97	1.90	0.93	0.93
25	0.90	0.98	0.90	1.12

Site	Period			
	1	2	4	5
26	0.37	0.40	0.39	0.47
27	0.37	0.36	0.36	0.53
28	1.14	1.42	0.70	0.53
29	0.69	1.11	0.86	1.34
30	0.87	0.67	0.70	1.07
31	0.94	0.96	0.74	0.96
32	0.91	0.78	1.26	1.28
33	0.84	1.00	0.96	0.96
34	0.88	1.04	0.84	0.49
35	0.94	0.87	1.72	0.96
36	1.01	0.82	0.61	0.89
37	1.80	0.82	0.79	1.48
38	0.79	0.64	0.70	0.76
39	1.66	1.18	1.90	1.80
40	1.50	1.68	1.93	2.59
41	1.11	0.88	0.82	1.12
42	2.00	1.06	1.54	1.59
43	1.18	0.88	0.87	1.46
44	2.34	1.50	1.61	4.10
45	1.60	1.37	1.87	2.58
46	1.87	1.41	1.21	1.39
47	1.79	1.10	1.12	0.99
48	1.81	0.74	1.34	1.06
49	0.99	0.51	0.73	0.99
50	0.88	0.83	3.58	2.11

TABLE 32. ANOVA ON COPPER IN SOIL SAMPLES
[ln (1 + X)]

Source	df	SS	MS	F	Significance Level
Periods	3	0.2364	0.0788	1.62	>0.20
Sites	49	12.7862	0.2609	5.36	<0.01
Period X Site (error)	147	7.1656	0.0487		
Total	199	20.1882			

Period Means [ln (1 + X)]

1	2	4	5
0.749	0.698	0.724	0.792

From the ANOVA and the means shown in the table, it is concluded that there were no changes in the copper content of the soil over the period of time under study. The range from lowest to highest average concentration over the four periods was only from 1.01 to 1.21 μg/g in the original scale, and no linear trend in the data can be observed.

As in the lead data, the mean square for interaction indicated that this was a valid source for the error term and that no unidentified interaction existed which complicated the results or conclusion.

Cadmium–The results of the analyses for cadmium content in soil samples are contained in Table 33. The summary of the ANOVA on these data is shown in Table 34 for the cadmium analyses over the four periods. The F-ratio for periods was significant at the 1-percent level and two sub-hypotheses were tested. The sites factor was also significant at the 1-percent level and the near vs. far sites hypothesis was tested for these data as well.

The period means as shown in the table indicate where the differences lie which are indicated by the F-ratio. The pre-operational means are of equivalent magnitude, but the post-operational winter mean is significantly lower while the fall mean is higher than the pre-operational means. The test for a pre- vs. post-effect, as a result, is not significant, with an estimated significance level of 20 percent. The Period 4 vs. Period 5 contrast gives a resulting F-ratio which is significant beyond the one-percent level. The transformed mean for Period 5 shown in the table represents an observed concentration of 0.47 μg/gm in the original scale.

Since there was a significant increase in Period 5, the site means were examined to see if the high concentration could be related to proximity to the plant. The contrast for near vs. far difference yields an F-ratio which is not significant, however. This implies that near and far sites had the same average observed levels. As a result, there is no indication that the rise in soil cadmium level is related to the plant operation.

The mean square for interaction represents the sampling error for these data. If the assumption of no interaction is incorrect, then this would be expected to be relatively large. As can be seen, however, this mean square is small compared to those for the period and site factors and the assumption is justified. The conclusion, then, is that no increase in soil cadmium was observed which can be attributed to the plant operation.

TABLE 33. DETERMINED CONCENTRATIONS OF CADMIUM
IN SOIL SAMPLES
(μg/gm, dry weight)

Site	Period				Site	Period			
	1	2	4	5		1	2	4	5
1	0.25	0.40	0.09	0.81	26	0.56	0.56	0.56	1.03
2	0.93	0.36	0.24	0.39	27	0.55	0.57	0.39	0.63
3	0.52	0.83	0.31	0.57	28	0.52	0.15	0.41	0.89
4	0.21	0.23	0.43	0.68	29	0.31	0.17	0.16	0.16
5	0.91	0.83	0.56	0.49	30	0.17	0.39	0.13	0.27
6	0.29	0.35	0.25	0.44	31	0.31	0.36	0.33	0.32
7	0.17	0.28	0.17	0.24	32	0.25	0.25	0.21	0.41
8	0.25	0.33	0.20	0.51	33	0.17	0.16	0.19	0.36
9	0.31	0.29	0.20	0.29	34	0.15	0.52	0.27	0.31
10	0.28	0.13	0.19	0.41	35	0.13	0.27	0.23	0.23
11	0.32	0.32	0.23	0.28	36	0.16	0.26	0.12	0.27
12	0.24	0.27	0.32	0.48	37	0.19	0.23	0.13	0.27
13	0.21	0.28	0.12	0.23	38	0.45	0.57	0.29	0.44
14	0.41	0.49	0.23	0.49	39	0.27	0.56	0.28	0.55
15	0.21	0.29	0.19	0.21	40	0.23	0.31	0.13	0.25
16	0.77	0.27	0.75	0.97	41	0.28	0.35	0.20	0.29
17	0.20	0.24	0.15	0.41	42	0.53	0.56	0.32	0.47
18	0.35	0.40	0.23	0.31	43	0.68	0.35	0.31	0.41
19	0.28	0.41	0.20	0.36	44	0.52	0.33	0.19	0.33
20	0.76	0.63	0.55	0.97	45	0.20	0.24	0.21	0.32
21	0.63	0.69	0.56	0.87	46	0.44	0.33	0.27	0.35
22	0.75	0.69	0.35	0.43	47	0.45	0.32	0.60	0.57
23	4.28	3.34	2.04	5.05	48	1.17	0.44	0.21	0.43
24	0.16	0.20	0.31	0.37	49	0.19	0.37	0.17	0.29
25	0.28	0.28	0.25	0.37	50	0.27	0.72	0.13	0.35

TABLE 34. ANOVA ON CADMIUM IN SOIL SAMPLES
[ln (1 + X)]

Source	df	SS	MS	F	Significance Level
Periods	3	0.4523	0.1508	15.08	<0.01
1, 2 vs 4, 5	1	0.0177	0.0177	1.77	~0.20
4 vs 5	1	0.2175	0.2175	21.75	<0.01
Sites	49	7.7381	0.1579	15.79	<0.01
near vs far	1	0.0007	0.0007	<1	N.S.
Period X Site (error)	147	1.4726	0.0100		
Total	199	9.6630			

Period Means [ln (1 + X)]

1	2	4	5
0.339	0.340	0.255	0.387

Mercury--The mercury analyses on soil samples are contained in Table 35. These were used in the ANOVA model above to obtain the ANOVA summary in Table 36. The periods factor was not significant for these data, with an approximate level of 10 percent. The period means as shown in the table further suggest that no general increase occurred in environmental levels of Hg in soil. The significance of the site factor is to be expected, but need not be considered in view of the lack of significance of the period term.

As with the previous data, the magnitude of the mean square for the interaction suggests that the assumption of an additive model is correct. It is concluded, then, that no observable rise in the Hg levels in soil could be attributed to the plant operation.

TABLE 35. DETERMINED CONCENTRATIONS OF MERCURY IN SOIL SAMPLES
(μg/gm, dry weight)

Site	Period 1	2	4	5
1	0.04	0.04	0.04	0.10
2	0.09	0.04	0.04	0.05
3	0.04	0.07	0.06	0.05
4	0.04	0.03	0.10	0.05
5	0.05	0.11	0.04	0.04
6	0.04	0.04	0.04	0.04
7	0.06	0.05	0.04	0.04
8	0.03	0.04	0.04	0.05
9	0.04	0.04	0.04	0.05
10	0.06	0.05	0.06	0.10
11	0.04	0.04	0.04	0.05
12	0.03	0.04	0.04	0.07
13	0.03	0.04	0.03	0.05
14	0.04	0.05	0.03	0.05
15	0.03	0.03	0.03	0.04
16	0.10	0.04	0.13	0.15
17	0.02	0.04	0.03	0.07
18	0.04	0.05	0.04	0.06
19	0.03	0.19	0.03	0.05
20	0.06	0.05	0.04	0.08
21	0.10	0.06	0.06	0.08
22	0.08	0.07	0.04	0.07
23	0.27	0.10	0.11	0.13
24	0.03	0.05	0.04	0.06
25	0.04	0.03	0.03	0.04
26	0.08	0.10	0.06	0.09
27	0.09	0.61	0.06	0.08
28	0.05	0.03	0.03	0.07
29	0.05	0.03	0.03	0.04
30	0.05	0.10	0.04	0.06
31	0.05	0.03	0.03	0.05
32	0.05	0.02	0.02	0.04
33	0.05	0.03	0.04	0.06
34	0.04	0.03	0.03	0.05
35	0.04	0.03	0.03	0.04
36	0.04	0.03	0.04	0.06
37	0.04	0.03	0.03	0.04
38	0.07	0.04	0.04	0.07
39	0.05	0.03	0.03	0.04
40	0.04	0.03	0.03	0.04
41	0.04	0.03	0.03	0.05
42	0.04	0.16	0.04	0.04
43	0.04	0.04	0.04	0.05
44	0.04	0.03	0.04	0.05
45	0.04	0.03	0.03	0.05
46	0.05	0.03	0.03	0.08
47	0.04	0.17	0.05	0.05
48	0.05	0.03	0.04	0.05
49	0.06	0.03	0.03	0.05
50	0.03	0.03	0.03	0.05

TABLE 36. ANOVA ON MERCURY IN SOIL SAMPLES
[ln (1 + X)]

Source	df	SS	MS	F	Significance Level
Periods	3	0.0091	0.0030	2.31	0.10
Sites	49	0.1339	0.0027	2.08	<0.01
Period X Site (error)	147	0.1931	0.0013		
Total	199	0.3361			

Period Means [ln (1 +X)]

1	2	4	5
0.048	0.057	0.039	0.055

Zinc–The analytical results for zinc in soil are shown in Table 37, and the summary of the ANOVA on these data in Table 38. Analyses on the soil samples for zinc content were made only on samples from the first three periods. The periods factor in the ANOVA proved to be insignificant for these data, showing less variability than the interaction term. The period means shown represent a range of only 13.28 to 13.82 mg/g average concentration from low to high.

As will be noted, the interaction term is relatively high and the possibility exists that the no-interaction model is not justified for these data. As a result, the hypothesis of near sites equal to far sites is tested in spite of the lack of an observable period effect. The F-ratio for this hypothesis is much less than one, and no difference can be found between those close to the plant and those farther away.

TABLE 37. DETERMINED CONCENTRATIONS OF ZINC IN SOIL SAMPLES
(μg/gm, dry weight)

Site	Period		
	1	2	4
1	4.31	11.55	38.75
2	8.72	10.56	6.95
3	10.11	17.28	39.48
4	12.93	7.80	42.14
5	11.73	10.76	11.21
6	6.51	18.26	7.19
7	11.93	14.71	11.45
8	4.51	28.92	5.06
9	12.93	13.72	13.33
10	14.27	3.43	14.04
11	6.98	7.55	8.15
12	16.24	17.35	31.88
13	8.76	7.55	8.15
14	17.22	21.46	10.24
15	3.83	9.51	4.65
16	32.95	9.12	12.33
17	17.22	14.80	18.15
18	50.12	83.32	10.24
19	11.32	17.74	10.71
20	23.32	22.25	13.96
21	15.83	12.25	28.87
22	39.04	43.42	26.78
23	42.73	55.65	36.31
24	6.00	3.04	5.54
25	6.03	8.33	7.58
26	26.42	29.71	46.08
27	30.18	28.35	23.37
28	8.60	3.02	13.93
29	6.23	4.77	8.27
30	32.35	36.72	15.55
31	9.20	7.70	8.70
32	9.59	9.65	16.84
33	14.55	10.62	13.90
34	4.45	36.92	20.84
35	2.47	4.39	15.70
36	6.03	6.14	8.03
37	7.62	3.61	7.12
38	41.85	40.27	32.69
39	32.55	22.50	25.13
40	9.21	101.76	6.89
41	43.71	16.37	6.55
42	34.60	22.21	32.19
43	20.71	25.91	11.82
44	21.51	10.91	9.53
45	16.95	4.67	8.60
46	20.71	5.46	8.83
47	22.70	9.74	37.48
48	42.92	10.32	7.69
49	16.16	15.58	14.11
50	14.57	6.82	5.97

TABLE 38. ANOVA ON ZINC IN SOIL SAMPLES
(ln X)

Source	df	SS	MS	F	Significance Level
Period	2	0.0423	0.0212	<1	N.S.
Site	49	46.7569	0.9542	2.79	<0.01
Near vs Far	1	0.0954	0.0954	<1	N.S.
Period X Site (error)	98	33.5337	0.3422		
Total	149	80.3329			

Period Means (ln X)

1	2	4
2.626	2.586	2.600

As for the previous metals, the conclusion regarding the environmental levels of zinc in soil samples is that no effect of the plant's operation could be detected on the observed concentrations.

Findings–

The findings from the statistical analyses on soil sample analytical data are summarized in Table 39. Only one of the parameters, lead, showed an increase in the post-operational period and for this the distance comparison showed that the far sites were higher than those close to the plant. As a result, none of the soil data indicated that there was a relationship between the results obtained and the operation of the sewage treatment plant.

TABLE 39. STATISTICAL FINDINGS SUMMARY–SOIL SAMPLES

	Seasonal Effect (Winter vs Fall)	Statistical Inferences Operational Effect (Baseline vs Operational)	Distance Effect (Near vs Far)	Indicated Relationship to Sewage Treatment Plant
Microbiological				
Standard Plate Count	Fall increase	Operational decrease	No difference	None
Trace Metals				
Cadmium	Fall increase	No difference	No difference	None
Copper	No difference	No difference	Not done	None
Lead	Fall increase	Operational increase	Higher at far sites	None
Mercury	No difference	No difference	Not done	None
Zinc	No difference	No difference	No difference	None

Water Samples

Samples from the 10 sites (ponds and streams) were taken for microbiological and trace metal analyses.

The microbiological analyses sought pathogenic bacteria and enteric viruses, but also included such sewage indicators as coliforms and fecal Streptococci. The concentrations of the trace metals, lead, copper, cadmium, zinc, and mercury, were also determined for each water sample. The results of these analyses and the conclusions obtained from the data analysis are presented below.

Statistical Methods–

The data bases for the water analyses take the form of a four by ten matrix of results, with four periods and ten sampling sites. The statistical analysis for these follows the same general procedure as used in the soil analyses. An ANOVA model is used with factors of periods and sites, and the assumption of additivity is made; that is, that no interaction exists between periods and sites. Thus, the residual sum of squares after accounting for period and site difference is assumed to be due to sampling error and is used as the basis for the denominator in the F-tests of significance.

The effect of the treatment plant operation on the water quality is estimated using orthogonal contrasts among the periods and sites as in the soil. If a significant periods term is noted, then two hypotheses are tested:

$$Ho_1 : \mu_1 + \mu_2 - \mu_4 - \mu_5 = 0$$
$$Ho_2 : \mu_4 - \mu_5 = 0$$

The first tests for an overall change from the pre- to the post-operational period and the second tests for a change from the winter to fall period. Sums of squares for the contrasts are partitioned out of the periods sum of squares with one degree of freedom each. The test for significance is an F-ratio compared to the error mean square. For any contrast for which a significant effect is noted, the direction of the difference is noted and conclusions drawn.

To support any findings which indicate that the treatment plant operation may impact on the environment, a third hypothesis is used. If the periods factor is significant, then the hypothesis of site differences due to closeness to the plant is tested. For the purposes of this study, sites falling in and around the 500-m radius of the plant are considered "near" and the remainder of the sites "far." There are four near sites and six far ones using this criterion, and the hypothesis becomes:

$$Ho_3: 3(\Sigma\mu_N) - 2(\Sigma\mu_F) = 0$$

where

$\Sigma\mu_N$ - sum of the near site means

$\Sigma\mu_F$ - sum of the far site means

and 3 and 2 are used to bring the sum of the coefficients to zero, as required for a contrast.

The treatment plant might be implicated as a source when the baseline vs. operational period contrast is significant and the result is possibly attributable to the plant by a near site vs. far site comparison. If no significant site factor is observed or if the site contrast is not significant, then the period result will be attributed to a general increase or decrease in the studied variable unrelated to the treatment plant.

Microbiological–

Despite a thorough screening, no pathogenic bacteria or enteric viruses were found in any of the water samples from any sampling period. All pathogenic bacteria were sought, including Klebsiella pneumoniae, Proteus, Pseudomonas, Salmonella, Shigella, Staphylococcus aureus, and Streptococcus-beta. Since no fecal coliforms were found in any water sample, the levels of fecal coliforms were below the analytical detection limit of 1 MPN/100ml. Quantitative determinations were obtained for total coliform and standard plate count. These data are analyzed below.

The total coliform concentrations in MPN/100ml are presented in Table 40 for the water samples. E. coli and enterobacter were identified as predominant coliforms present. There is a slight increase pairwise between the corresponding season periods. From October 1974 to October 1976, the observed values increased to 161 for all sites. From February 1975 to February 1976, there was an increase in the number of sites showing a positive response, with two sites at the 161 level.

Since MPN data are only semiquantitative, a sign test has been used to assess these values in relation to the possible effects of the treatment plant. To obtain sufficient data, the sites were compared seasonally, i.e., Period 1 vs. Period 5 and Period 2 vs. Period 4, and the results pooled to test for significance. The 20 pairs thus generated show differences from pre- to post-operational of nine increases, one decrease, and 10 no-change. Using the convention that no-change comparisons be deleted from the data set, the result is a sample of size 10 with nine pluses and one minus. From a table of the distribution of the test statistic, the significance level of this result is approximately 0.02, and is significant at the 5-percent level. Thus, there is some indication of a change in the post-operational periods, although the overall levels are quite low.

To assess the effect of the plant on these changes, the distance of the site from the plant is considered. Sites 1, 3, 4, and 5 can be considered "near" sites, falling at or near the 500-m circle from the first stage aeration basin. Of the increases observed, three of the nine were at near sites and the remaining six at the far. Percentage-wise, this is 3/8 = 0.375 vs. 6/12 = 0.50, and thus there is no tendency for the increases to be related to the closeness to the plant. There is no evidence, then, that the increases in the total coliform levels seen in the post-operational period are related to the sewage treatment plant.

The standard plate count data are shown in Table 41, and provide the only data from all sites and periods. As with the soil samples, the data from the first period are higher than those from the subsequent periods by over an order of magnitude in many cases. It is not clear whether this reflects elevated shipping temperature or actually represents higher bacterial levels. In any event, it dominates the statistical analyses.

Due to the skew nature of the plate count data, the data were first transformed using a natural logarithmic transformation prior to running the ANOVA. This helps reduce the anomalous nature of the first period's data. The ANOVA is summarized in Table 42.

The periods factor is significant beyond the one-percent level, as could be expected from the fact that such high values were reported for period 1. The pre-operational vs. post-operational contrast was significant, as could be expected, but the comparison between Periods 4 and 5 proved nonsignificant. To further evaluate these results, a Least Significant Difference (LSD) statistic was calculated for these data. The LSD allows pairwise comparisons of means at a given significance level to determine which are equivalent and which are different. The LSD for this test is calculated as:

$$\text{LSD}_{.05} = t_{.05}(27)\sqrt{\frac{MS_E}{n}}$$

where

$t_{.05}(27)$ - t-value at $\alpha = 0.05$ with 27 df

MS_E - mean square for error from the ANOVA with 27 df

n - number of observations in the sample

Substituting gives

$$\text{LSD}_{.05} = (2.052)\sqrt{\frac{3.350}{10}}$$

$$= (2.052)(0.579)$$

$$= 1.19.$$

TABLE 40. TOTAL COLIFORM FOR WATER SAMPLES (MPN/100 ml)

Site	Period			
	1	2	4	5
1	<1	<1	<1	161
2	161	<1	<1	161
3	4	<1	1	161
4	161	<1	<1	161
5	5	<1	161	161
6	161	<1	<1	161
7	<1	1	<1	161
8	161	<1	<1	161
9	18	<1	<1	161
10	1	<1	161	161

TABLE 41. STANDARD PLATE COUNT FOR WATER SAMPLES (no./ml × 10^3)

Site	Period			
	1	2	4	5
1	82	41	45	0.69
2	610	4.2	0.12	7.8
3	350	0.37	91	12
4	320	6.6	28	0.47
5	64	0.55	3	4.4
6	370	1.2	5	0.29
7	910	13	0.43	38
8	93	0.15	19	0.32
9	760	2.1	2.7	0.33
10	82	0.23	0.42	4.1

TABLE 42. ANOVA ON STANDARD PLATE COUNT IN WATER SAMPLES (ln X)

Source	df	SS	MS	F	Significance Level
Periods	3	164.027	54.676	16.32	<0.01
1, 2 vs 4, 5	1	39.105	39.105	11.67	<0.01
4 vs 5	1	3.20	3.20	<1	N.S.
Sites	9	22.308	2.479	<1	N.S.
Period X Site (error)	27	90.458	3.350		
Total	39	276.793			

Period Means (ln X)

1	2	4	5
5.490	0.557	1.446	0.646

Thus, two means must differ by more than 1.19 to be considered separable at the 0.05 level. The range, however, for the means except for Period 1 is only 1.446 - 0.557 = 0.889 and no difference is detectable. The conclusion, then, is that only Period 1's value can be considered different, and that the plate count data do not indicate any effect on the environment due to the operation of the treatment plant.

Trace Metals–

The water samples were analyzed for lead, copper, cadmium, zinc, and mercury content during Periods 1, 2, 4, and 5. The results from these analyses are used to evaluate the effect of the plant's operation on environmental levels of these metals. Where appropriate, the ANOVA model described in the water sample statistical methods section is used for this evaluation. In other instances, the data are inadequate and an evaluation is used based upon the mean values calculated for each period.

In the water samples, there are frequent observations which fall below the detection limit of the method. For these, a value equal to one-half the detection limit is used in the statistical analyses. The rationale behind this is that this would be the average expected value of these results if they are nearly equally likely and that the value of the detection limit is sufficiently low that this could not be expected to unduly influence the results.

The sample from site 1, Period 1 was analyzed in duplicate or triplicate on the majority of the metals. For this value, the average of the results is used in succeeding analyses, while the tables reflect all of the analyses made. The results of the statistical analysis are presented below for each metal under study.

Lead–The results of the analyses for lead in water samples are shown in Table 43 and are used to obtain the ANOVA in Table 44. The results are multiplied by 10^4 for ease of computation and presentation. As can be seen, the period factor is not significant at the 5-percent level, with an estimated significance of 0.13. The sub-hypotheses for the period term are partitioned from the sum of squares since there is a marginal probability of a period effect. As can be seen, however, the contribution of the sum of squares due to a pre- vs. post-operational effect or a Period 4 vs. Period 5 effect was minimal, and no significant variation could be detected.

The sites term was clearly nonsignificant at any reasonable level, and no partitioning was made of this term. However, the error mean square was of sufficient magnitude to suggest that there may have been an interactive effect and that the sum of squares may not be attributable merely to sampling error. This hypothesis is tested using Tukey's test of nonadditivity,(47) which evaluates the validity of the assumption of additivity in the model. A sum of squares for nonadditivity is partitioned from the error sum of squares and

TABLE 43. LEAD CONTENT OF WATER SAMPLES
(mg/ℓ)

Station	Period			
	1	2	4	5
1	0.0056 0.0041 0.0044	0.0197	0.0069	0.0136
2	N.D.*	0.0042	N.D.	0.0057
3	0.0047	0.0154	0.0059	0.0163
4	0.0045	0.0207	0.0069	0.0145
5	N.D.	N.D.	0.0058	N.D.
6	0.0051	0.0088	0.0087	N.D.
7	N.D.	0.0095	0.0030	N.D.
8	0.0028	0.0241	N.D.	0.0049
9	0.0059	0.0049	0.0310	N.D.
10	0.0059	N.D.	0.0095	N.D.

---

*N.D.–none detected. Detection limit: 0.0027 mg/ℓ.

TABLE 44. ANOVA ON LEAD IN WATER SAMPLES
(mg/ml × 10^{-4})

Source	df	SS	MS	F	Significance Level
Periods	3	2.7921	0.9307	2.12	0.13
1, 2 vs 4, 5	1	0.0073	0.0073	<1	N.S.
4 vs 5	1	0.1711	0.1711	<1	N.S.
Sites	9	4.7869	0.5319	1.21	N.S.
Period X Site (error)	27	11.8612	0.4393		
Nonadditivity	1	0.2019	0.2019	<1	N.S.
Remainder	26	11.6593	0.4484		
Total	39	19.4402			

Period Means (mg/ml)

1	2	4	5
0.0038	0.0110	0.0081	0.0062

tested for significance by an F-ratio against the mean square of the remainder of the sum of squares. For this ANOVA, the mean square is less than one and the additivity is determined to be a valid assumption.

The conclusion, then, is that no increase in environmental levels of lead in water was observed after the plant became operational.

Copper–Analyses were made on the water samples for copper content only on the first two periods samples. As a result, the results are summarized by mean and standard deviation only. The data and summary statistics are contained in Table 45. The mean for Period 1 was 0.0085 mg/ℓ, while Period 2 showed an average of 0.0243 mg/ℓ, roughly three times as large.

No assessment of plant effect is possible from these data and they were not investigated further.

TABLE 45. COPPER CONTENT IN WATER SAMPLES
(mg/ℓ)

Station	Period 1	Period 2
1	0.0070 0.0073	0.0228
2	N.D.*	0.0046
3	0.0078	0.0400
4	0.0175	0.0188
5	N.D.	0.0072
6	0.0084	0.0101
7	0.0136	0.0746
8	N.D.	0.0126
9	0.0198	0.0461
10	0.0076	0.0065
Mean†	0.0085	0.0243
Std Dev	0.0062	0.0227

---

*N.D.–none detected. Detection limit: 0.0032 mg/ℓ.

†Summary statistics calculated using 0.0016 for N.D. values.

Cadmium–The results of these analyses for cadmium content in the water samples are shown in Table 46. As can be seen, the vast majority of these determinations fell at or below the detection limit of the method. Only three values were above 0.0007 mg/ℓ, and none of these occurred in the two post-operational periods. The high frequency of results below the detection limit makes a formal statistical analysis of the data unwarranted. Since the results of the Periods 4 and 5 analyses were low, however, it can be concluded that there was no significant effect on the water due to cadmium arising from the plant operation.

TABLE 46. CADMIUM CONTENT IN WATER SAMPLES
(mg/ℓ)

Station	Period			
	1	2	4	5
1	0.0008 0.0013	0.0021	N.D.*	N.D.
2	N.D.	N.D.	N.D.	N.D.
3	N.D.	0.0007	N.D.	N.D.
4	N.D.	N.D.	N.D.	N.D.
5	N.D.	N.D.	N.D.	N.D.
6	N.D.	N.D.	N.D.	N.D.
7	N.D.	0.0022	0.0007	N.D.
8	N.D.	N.D.	N.D.	N.D.
9	N.D.	N.D.	N.D.	N.D.
10	N.D.	N.D.	N.D.	N.D.
Mean[†]	–	0.00074	0.00037	–
Std Dev	–	0.00075	0.00011	–

---

*N.D.–none detected. Detection Limit: 0.00067 mg/ℓ.

[†] Summary statistics calculated using 0.00034 for N.D. values.

Mercury–The analysis of the water samples for mercury content produced the results shown in Table 47. One-half of the detection limit was substituted for the low values and the data submitted to an ANOVA procedure. The ANOVA is summarized in Table 48.

The sums of squares and mean squares shown in the table were obtained from using a factor of 10^5 times the observed concentration. This is done for ease of computation and presentation.

The periods factor is significant beyond the one-percent level and the two sub-hypotheses of interest are tested. The pre- vs. post-operational contrast is significant beyond the one-percent level. The values of the period means thus indicate that there was an increase in the observed levels of mercury after the plant went into operation. The magnitude of the difference, however, is only 2.2×10^{-5}, and may not be large enough to be of practical significance.

TABLE 47. MERCURY CONTENT OF WATER SAMPLES
(mg/ℓ)

Station	Period			
	1	2	4	5
1	0.00004	N.D.	0.00003	0.00003
2	0.00004	N.D.	N.D.	0.00003
3	0.00003	N.D.	0.00005	0.00003
4	0.00002	N.D.	0.00005	0.00005
5	N.D.*	N.D.	0.00005	0.00008
6	0.00004	N.D.	0.00009	0.00005
7	0.00003	N.D.	N.D.	0.00005
8	0.00002	N.D.	0.00008	0.00003
9	0.00002	0.00002	0.00004	N.D.
10	N.D.	N.D.	0.00003	N.D.

---

*N.D.–none detected. Detection limit: 0.00002 mg/ℓ.

TABLE 48. ANOVA ON MERCURY IN WATER SAMPLES
(mg/ml × 10^{-5})

Source	df	SS	MS	F	Significance Level
Periods	3	62.10	20.70	6.55	<0.01
1, 2 vs 4, 5	1	48.40	48.40	15.32	<0.01
4 vs 5	1	1.23	1.23	<1	N.S.
Sites	9	30.40	3.38		
Period X Sites (error)	27	85.40	3.16		
Total	39	177.90			

Period Means (mg/ml × 10^{-5})

1	2	4	5
2.60	1.10	4.40	3.70

The sites factor was not significant for these data and the conclusion is that the change in the overall levels of mercury in water was unrelated to distance from the plant. For mercury in water samples, then, there is no evidence that the changes in the environmental levels are related to the treatment plant operation.

Zinc–Analyses for concentration of zinc in the water samples were made only on samples from the first two sampling periods. The mean for Period 1 was 0.0512 mg/ℓ, and for Period 2 was 0.0549 mg/ℓ. The analytical results and the means and standard deviations are shown in Table 49.

Since only pre-operational data are available, there was no assessment of the effect of the plant on the surrounding area possible from these data.

TABLE 49. ZINC CONTENT OF WATER SAMPLES
(mg/ℓ)

Station	Period 1	Period 2
1	0.0581 0.0653	0.0566
2	N.D.*	N.D.
3	0.0407	0.1305
4	0.0546	0.0443
5	0.1499	N.D.
6	0.0476	N.D.
7	0.0290	0.2020
8	0.0244	0.0591
9	0.0709	N.D.
10	N.D.	N.D.
Mean†	0.0512	0.0549
Std Dev	0.0386	0.0642

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*N.D.–none detected. Detection limit: 0.0223 mg/ℓ.

†Summary statistics calculated using 0.0112 in place of N.D. values.

Findings–

The findings of the study related to environmental water samples are summarized in Table 50. For the microbiological analyses, total coliform results showed a tendency to increase from the pre- to the post-operational period, but no relationship of the distance to the plant to these increases could be found. The post-operational standard plate count data showed a decrease from the earlier levels, but this is attributable to the Period 1 results and is considered questionable. The remaining three periods were not significantly different from one another. Thus, no relationship to the sewage treatment plant is indicated by these data.

TABLE 50. STATISTICAL FINDINGS SUMMARY - WATER SAMPLES

	Statistical Inferences			Indicated Relationship to Sewage Treatment Plant
	Seasonal Effect (Winter vs Fall)	Operational Effect (Baseline vs Operational)	Distance Effect (Near vs Far)	
		Microbiological		
Total Coliform	Fall increase	Operational increase	No difference	None
Standard Plate Count	No difference	Operational decrease (?)	-	None
		Trace Metals		
Cadmium, copper, zinc	No statistical analysis warranted			-
Lead	No difference	No difference	-	None
Mercury	No difference	Operational increase	No difference	None

The cadmium, copper, and zinc results did not permit an assessment of the treatment plant effect. The lead data showed no period effects and no relationship between sites due to distance from the plant. The operational levels of mercury were higher than the baseline levels, but no relationship to nearness to the plant could be detected. The trace metal data, then, as did the microbiological, give no indication of a relationship between the operation of the sewage treatment plant and the trace metal content of the environmental water samples.

HOUSEHOLD HEALTH SURVEY

Household and Personal Characteristics

The information obtained on the households and the residents therein was obtained for two purposes; first, to describe the populations sampled, and second, to allow a comparison to be made between the two sets of households. To fully assess the health information obtained and to evaluate the results, the two samples should be well-matched or the differences must be known and accounted for in the conclusions drawn. The questionnaire data relating to the household itself, the heads of household, and the individuals in residence are summarized below for both surveys and compared for consistency.

Household Distributions–

The number of households surveys was 1107 in 1974 and 1109 in 1976. Information on households was collected in two general categories; socioeconomic characteristics and exposure characteristics. Socioeconomic status was evaluated by the education and occupation of the head of the households, the size of the household, the race of the individual interviewed, and the number of bedrooms in the house. The number of bedrooms is presumed to indicate the economic status of the household to a limited degree. Exposure characteristics included the location, with respect to the map sectors discussed above, distance from the Egan plant, distance from other potential sources of pollutants such as roadways or industries, length of residence at that address, length of residence in that city or town, and extent of air-conditioning. The information obtained in the survey is summarized below for those categories.

Socioeconomic Factors–The education of the heads of the households was obtained and is summarized in Table 51. Of the 1100 heads of household in 1974, 63 percent had some college and 35 percent had completed college. The 1976 data were similar, with percentages of 64 and 35, respectively. Compared to the 1970 census data, only 7.2 percent of those in the surrounding area had completed 4 years of college, but the changes in the resident's characteristics in the period between 1970 and 1976 discussed in Section 4 above accounts for much of this difference.

TABLE 51. COMPARATIVE EDUCATIONAL LEVELS

Educational Level of Head of Household	Baseline	Operational
8th Grade	29	30
High School Incomplete	38	48
High School Complete	340	339
College Incomplete	309	311
College Complete	277	265
Graduate School	107	113

The occupations of the heads of households are shown in Table 52 grouped into general classifications. As can be seen, there was a shift in the occupational distribution between the 1974 and 1976 surveys. The percentage of people employed in professional and administrative positions was 17.3% in 1974 and 34.0% in 1970. The 1970 census data showed 31.3% of the total employed being in professional or managerial positions. The shift in the occupations of the persons surveyed also probably reflects the shift in the residential nature of the area discussed above.

TABLE 52. COMPARATIVE OCCUPATIONAL DISTRIBUTIONS

Occupation of Head of Household	Baseline	Operational
Professional	73	112
Administrative	118	194
Technical	192	178
Clerical	68	24
Sales	150	158
Foremen/Craftsmen	274	196
Laborer	105	74
Teacher	25	24
Public Assistance	20	26
Retired	32	46

The distribution of the size of the residences involved in the survey is shown in Table 53. The number of bedrooms as an indicator of relative affluence is imperfect, but the frequency of three- and four-bedroom dwellings gives an indication that the exposed population is above the lower class or poverty-level income. The increase in relative frequency of smaller bedroom dwellings probably results from apartment complexes included in the 1976 survey which did not exist at the time of the 1974 survey. The majority of apartments are two-bedroom, so the results in the table should not be interpreted to reflect a shift downward in the income level over the two-year span.

TABLE 53. COMPARATIVE SIZE OF RESIDENCES

Number of Bedrooms	Baseline	Operational
1	4	16
2	110	191
3	693	618
4	257	245
5+	43	37

The households were identified by sector on the survey, with the sector designation being made according to the map shown in Figure 2 in Section 4. The sectors and the numbers of households surveyed in each are summarized in Table 54. The baseline survey of 61 Lexington Green Apartment households within 700 m of the plant site was actually made in late September 1974. In the baseline survey, the pattern is somewhat irregular, but at least 19 households were obtained in each sector and over 50 in the majority. In the operational survey, the workers obtained a nominal 50 from each sector, with one or two extras in five of the sectors. As such, they do not necessarily reflect the population density in those sectors, but rather a sampling of the households from various distance-direction locations.

TABLE 54. DISTRIBUTION OF HOUSEHOLDS BY SECTOR

Area of Residence by Sector	Baseline	Operational
Lexington Green Apartments	61	50
1	33	51
2	44	50
3	67	50
4	65	50
5	50	51
6	57	50
7	56	50
8	47	51
9	51	50
10	51	52
11	51	50
12	25	50
13	51	50
14	49	51
15	19	50
16	52	52
17	51	50
18	50	50
19	75	51
20	51	50
21	51	50

The households were classified by the number of members in the family, and this is summarized in Table 55. As can be seen, there is a wide range of sizes, with a significant percentage for both years falling in the groups with between two and six members, inclusive. This range spans the expected family size of an American family and is considered to be representative.

TABLE 55. COMPARATIVE FAMILY SIZE DISTRIBUTIONS

Number of Members	Baseline	Operational
1	24	34
2	189	192
3	188	227
4	324	317
5	226	206
6	94	77
7	36	36
8	14	14
9+	12	6

The racial characteristics of the surveyed individuals conform to those of the area, with the great majority of the persons interviewed identified by the interviewers as white. The summary of the findings is shown in Table 56. In 1974, the interviewer failed to record the race of the subject in 153 of the cases, but the percentage of whites among the responses was 96.7. In 1976, the percentage of whites was 96.5, which corresponds well. The 1970 census of the surrounding area showed 99.3% classified as white, so these figures may be said to be representative of the area.

TABLE 56. COMPARATIVE RACIAL DISTRIBUTIONS

Race	Baseline		Operational	
	No.	%	No.	%
None indicated	153	14.68	0	0.0
Indian	2	0.19	7	0.63
Mexican-American	6	0.58	11	0.99
Negro	8	0.77	9	0.81
Oriental	5	0.48	12	1.08
White	860	82.53	1069	96.48
Other	8	0.77	0	0.9
TOTAL	1042		1108	

Exposure Characteristics–The distance of each household from the Egan plant was recorded. For the baseline survey, the distances were determined for one-kilometer circles around the plant, while the operational survey used one-half-kilometer circles. For comparison of the two groups, then, frequency classes of less than 1.0 km, 1.0 to 2.0, 2.0 to 3.0, 3.0 to 4.0, and 4.0 to 5.0 kilometers from the plant were used. The household distance distribution is shown in Table 57.

TABLE 57. COMPARATIVE DISTANCES FROM TREATMENT PLANT

Distance of Residence from Egan Plant, km	Baseline	Operational
0.0-1.0	67	82
1.0-2.0	167	94
2.0-3.0	194	238
3.0-4.0	319	333
4.0-5.0	360	358

To indicate exposure to sources other than the sewage treatment plant, the distance of the residences from expressways, major highways, and industries were recorded. Roadways are a source of trace metal air pollution, particularly lead and cadmium. Industries are a source of metals and other air pollutants which can affect the health of the populace. The summary tables for these criteria of classification are presented in Tables 58 through 60.

In 1976, the households obtained tended to be closer to expressways than in 1974. This was primarily in the 2 blocks to 1 mile range, where the percentage changed from 27.4 to 39.0. A similar pattern is seen for the relative distance to major highways. For this category, however, there was also a higher frequency in the close-in category. The percentages in these two exposure categories increased from 17.2 to 28.3, and from 33.1 to 36.8, respectively, for the two relatively high exposure categories.

The distance to an industrial source followed an irregular pattern. More households in the operational survey fell in the close-in category, but fewer fell in the intermediate classification. Overall, however, the majority of the households were more than one mile from any such source of pollutants in both periods.

TABLE 58. COMPARATIVE DISTANCES FROM NEAREST EXPRESSWAY

Distance	Baseline	Operational
Less than 2 blocks	56	71
2 blocks up to 1 mile	303	433
At least 1 mile	748	605

TABLE 59. COMPARATIVE DISTANCES FROM NEAREST MULTILANE HIGHWAY

Distance	Baseline	Operational
Less than 2 blocks	190	314
2 blocks up to 1 mile	366	519
1 mile or more	551	276

TABLE 60. COMPARATIVE DISTANCES FROM NEAREST INDUSTRY

Distance	Baseline	Operational
Less than 2 blocks	25	46
2 blocks up to 1 mile	135	64
1 mile or more	947	999

The length of residency of the individuals was recorded, both at the address and in the city in which the household was located. These were classified into less than one, one to three, and three or more years for purposes of summarizing the results. The residency at present address summary is shown in Table 61, and residency in city in Table 62.

TABLE 61. COMPARATIVE YEARS OF RESIDENCY AT PRESENT ADDRESS

Years	Baseline	Operational
Less than 1	259	220
1-3	296	282
3 or more	552	607

TABLE 62. COMPARATIVE YEARS OF RESIDENCY IN THE CITY

Years	Baseline	Operational
Less than 1	222	178
1-3	271	249
3 or more	614	682

The distributions for the two surveys are similar for the length of residency at the address. Of interest also is the fact that of the households in the operational survey, 80.2 percent had been at that address for one year or more, spanning the period during which the plant had been operational. The residency in the city distribution was similar, with 83.9 percent being in the city for at least one year, and exposed to the plant's entire period of operation. It is also noteworthy that 67.9 percent of the 1976 households had resided at least two years in the area, so they could also have been surveyed in 1974.

The final exposure characteristic concerns the extent of air-conditioning in the home. It has been noted that air-conditioning in the home removes many of the particles from the air which carry trace metals or other contaminants. The distribution of the households with regard to air-conditioning is shown in Table 63. The residences are divided into categories of none, window units, and central air-conditioning.

TABLE 63. COMPARATIVE HOUSEHOLD AIR CONDITIONING DISTRIBUTIONS

Air Conditioning	Baseline	Operational
None	277	195
Window	224	242
Central	604	670

The proportion with no air-conditioning decreased in 1976 from 25.0 percent to 17.6 percent. The proportion of window units was comparable in both surveys, while the increase occurred in the central system category. The developing nature of the area accounts for some of this, since most new homes are designed with a central unit, as does the increase in apartment houses following the baseline survey.

Household Member Distributions–

Distribution of Age and Sex–The households surveys in 1974 had 4428 members, while there were 4269 members in the 1976 households. The members of the households surveyed in both 1974 and 1976 were classified by age and are summarized in Table 64 for each sex. Fifteen age groupings were used for this comparison: 0-4, 5-9, 10-14, 15-19,... 65-69, and 70 and over.

The operational survey contained a lower frequency of children up to 14 years. In both surveys, the higher frequencies were those in the children and young adult classes spanning the ages from 0 to 39 in both sexes, with a slight decrease from the ages 20 to 24. This is consistent with the results cited above in the household characteristics and the growth of apartment dwellings in the interim between the two surveys.

Distribution by Age and Distance–To investigate the possibility that the observed differences in the incidence of illnesses, diseases, and symptoms in the household health survey resulted from inconsistencies between the two samples taken in 1974 and in 1976, the individuals were classified by their age group and relative to the distance from their residence to the Egan plant.

TABLE 64. COMPARATIVE AGE AND SEX DISTRIBUTIONS

Age	Baseline	Operational
	Male	
0-4	279	224
5-9	347	271
10-14	276	250
15-19	202	251
20-24	87	127
25-29	153	162
30-34	238	224
35-39	200	154
40-44	138	152
45-49	115	118
50-54	94	107
55-59	72	59
60-64	35	25
65-69	17	16
70+	22	29

(continued)

TABLE 64 (continued)

Age	Baseline	Operational
	Female	
0-4	250	182
5-9	298	264
10-14	231	235
15-19	205	210
20-24	97	137
25-29	217	235
30-34	248	209
35-39	162	151
40-44	128	151
45-49	101	95
50-54	85	94
55-59	45	41
60-64	33	33
65-69	18	23
70+	35	40
TOTALS	4428	4269

For this analysis, more general classifications of age were used which relate more closely to the frequency of illness. The classifications are: 0-5, 6-18, 19-45, 46-64, and 65 For each category, the total is subdivided by distance from the plant in three classes: 0-2.0 km, 2.0-3.5 km, and 3.5 to 5.0 km. These results are presented in Table 65, along with the percentage of the total sample that lies within that combination.

TABLE 65. COMPARATIVE AGE GROUP FREQUENCIES BY DISTANCE

Age	Distance	Baseline		Operational		Difference (Operational % - Baseline %)
		No.	%	No.	%	
0-5	0-2.0	146	3.3	104	2.4	-0.9
	2.0-3.5	246	5.6	189	4.4	-1.2
	3.5-5.0	288	6.5	219	5.1	-1.4
6-18	0-2.0	140	3.2	167	3.9	0.7
	2.0-3.5	580	13.1	512	12.0	-1.1
	3.5-5.0	619	14.0	616	14.5	0.5
19-45	0-2.0	358	8.1	288	6.8	-1.3
	2.0-3.5	680	15.4	706	16.6	1.2
	3.5-5.0	746	16.8	830	19.5	2.7
46-64	0-2.0	105	2.4	70	1.6	-0.8
	2.0-3.5	169	3.8	176	4.1	0.3
	3.5-5.0	257	5.8	272	6.4	0.6
65+	0-2.0	17	0.4	15	0.4	0.0
	2.0-3.5	36	0.8	38	0.9	0.1
	3.5-5.0	41	0.9	55	1.3	0.4
TOTAL		4428	100	4257	100	

As can be seen, both sexes there was a lower frequency of individuals falling in the youngest group at all three distances in the operational survey and a slightly higher frequency in the two older categories. Males comprised 51.4 percent of the household members in 1974 versus 50.8 in 1976, and females were 48.6 and 49.2 percent of the total.

To indicate the representativeness of the samples, the total frequencies for each age group, irrespective of distance, are calculated and presented in Table 66. The age groups do not match exactly, but are close enough to indicate good agreement with respect to age between the 1970 census data in Table 3, above, and the two samples taken. The percent of males in the 1970 population was 50.2, which also shows reasonable agreement with these data.

TABLE 66. COMPARATIVE AGE-SEX FREQUENCY
(Percentage of Total Population)

Age Group	Male		Female	
	Baseline	Operational	Baseline	Operational
0-5	8.2	6.3	7.3	5.7
6-18	15.9	15.8	14.4	14.5
19-45	19.6	20.8	21.5	22.0
46+	7.5	7.7	6.7	7.1

Shifts in Distribution Between the 1974 and 1976 Surveys—

Statistical Methodology—Each test for compatibility between the two survey groups was made using a chi-square test for independence. The null hypothesis was that the baseline and operational survey distributions were independent, so the relative frequency of any of the cross-classifications, e.g., baseline frequency of window air conditioner, can be accurately predicted by the relative frequency of the major classes. Thus no interactive or nonindependent causes, i.e., different distributions between years, are presumed to occur.

The model for the socioeconomic and exposure characteristics was a 2xk chi-square, with survey period at two levels and characteristics at k levels, where k is variable depending upon the nature of the question. The degrees of freedom for these are calculated as (2-1)(k-1) = k-1 for all cases. The test statistic is then compared against the chi-square distribution with k-1 degrees of freedom to determine the significance of the test.

For the age-sex and age-distance comparisons, a three-way model was used to evaluate the distributions. The degrees of freedom for the age-sex-year chi-square are computed as (15-1)(2-1)(2-1) = 14, for the 15 age divisions, two sexes, and two years. For the distance comparisons there are (5-1)(2-1)(3-1) = 8 df for this test, with five age groups, two years, and three distances.

The results of these chi-square tests and conclusions drawn are presented below for the variables under study.

Socioeconomic Factors—Table 67 contains the chi-square statistics for the socioeconomic factors, along with degrees of freedom and approximate significance levels. As can seen, the two samples were well-matched with respect to educational level, household size, and race of interviewee, all of which had significances levels in excess of 20 percent.

Occupational classifications and the number of bedrooms were not compatible, however, with highly significant chi-square values. For the occupational variable, this indicates a significantly higher proportion of the heads of household were employed in administrative and professional positions, and fewer in the craftsman and laborer categories.

TABLE 67. CHI-SQUARE INDEPENDENCE TEST SUMMARY–SOCIOECONOMIC CHARACTERISTICS

Characteristic	df	X^2	Significance Level	Change in Operational Survey
Education	5	1.60	>0.20	None
Occupation	9	101.4	<0.001	More professional and administrative classifications
Size of Household	8	10.10	>0.20	None
Race of Interviewee	4	3.98	>0.20	None
Number of Bedrooms	4	34.02	<0.001	Fewer bedrooms in residences surveyed

For the number of bedrooms category, the significant chi-square value resulted from a general shift from greater to smaller numbers of bedrooms per residence. This probably does not indicate a decline in the affluence of the neighborhood. Instead, as noted above, the probable explanation is that more apartment dwellings existed and were surveyed in 1976; apartments tended to have fewer bedrooms than do houses.

Exposure Characteristics–Table 68 contains the chi-square statistics for the exposure characteristics between the two surveys. As can be seen, all the test statistics are significant at the 5-percent level, and all but three are significant beyond the 0.1-percent level. Thus, for these characteristics, the two survey groups did differ.

TABLE 68. CHI-SQUARE INDEPENDENCE TEST SUMMARY–EXPOSURE CHARACTERISTICS

Characteristic	df	X^2	Significance Level	Change in Operational Survey
Location	21	37.67	0.01	More balanced than baseline
Distance From Plant	4	26.75	<0.001	Shift from 1.0-2.0 to 2.0-3.0 km
Distance to Nearest Expressway	2	39.85	<0.001	Closer to express-ways
Distance to Nearest Multilane Highway	2	148.4	<0.001	Closer to highway
Distance to Nearest Industry	2	32.93	<0.001	More within 2 blocks
Length of Residence at Present Address	2	6.12	0.05	Shift from less than 1 to over 3 years
Length of Residence in City or Town	2	9.34	0.01	Shift from less than 1 to over 3 years
Air-Conditioning	2	18.36	<0.001	More central A/C

The potential effect of these changes was investigated. First the location factor is significant due to the balance among the sectors assured in the second survey. Fifty households were surveyed in each sector in 1976, while the number ranged from 19 to 75 in 1974. This causes the chi-square to be high, but does not necessary imply differing exposure patterns.

Similarly, the distance from the plant is significant, due to a higher percentage of the operational survey lying in the 2.0-3.0 km range of the plant and fewer in the 1.0 to 2.0 km range. This could definitely affect the outcome of the health effects study and the relative distance from the plant is thus considered in all subsequent analyses.

The distance from the residence to major roadways decreased for the 1976 survey in both the expressway and multilane highway categories. The residences were closer on the whole, and this could result in higher exposure to pollutants from automobile exhaust, including trace metals. The increased exposure to this type of pollution is a confounding factor in the results and must be considered when drawing any conclusions.

Distance to the nearest industry was significantly but not uniformly different. Overall, the households within one mile of the plant decreased, but the number within two blocks roughly doubled, from 25 to 46. However, 85 to 90 percent of the households in both surveys were over one mile from the nearest industry, and this was not considered to be a major source of confounding in the analyses.

The residency factors were similar, with both showing a decrease in the less than one year category, and an increase in the over three years category. This does not indicate a problem, however, since more of the residents surveyed would have been exposed during the treatment plant's operational period.

The air-conditioning of residences was more extensive in the households surveys in the operational period. Air-conditioning eliminates particles from the air which might contain sources of disease and health hazard. Thus, if this difference affects the disease and symptom results of the health survey, it would be expected to lower the occurrence of the diseases and symptoms under study during the 1976 operational period survey.

Age-Sex Distribution--The chi-squared statistic for the change in age-sex distribution of the household members was calculated to be 123.77 with 14 df. This has a significance level of less than 0.1 percent, and thus a significant change had occurred. Fewer children, especially in the two lowest age categories, 0 to 4 and 5 to 9 years, of both sexes were surveyed in 1976. For those symptoms or illnesses which would be expected to occur more frequently in children, there would be an expected decrease in incidence in the operational period survey (1976) relative to the baseline period survey (1974), all other things being equal.

Age-Distance Distribution--The chi-squared statistic for comparison of the two surveys by age group and distance from the plant was calculated to be 134.85 and has 8 degrees of freedom associated with it. The significance level for this test is less than 0.001, and clearly indicates that the two surveys differed in their age-distance make-up. As in the above data, there were fewer children overall in the operational survey and fewer at the 0-2.0 km distance.

As a result, any of the illness, diseases, or symptoms for which a potential health effect is observed must be considered in terms of the age pattern relative to the incidence of the disease and to the distance from the Egan plant, considered together.

Analysis of Health Survey Illness, Disease and Symptom Incidence

Statistical Methodology--

The data from the Household Health Survey are in the form of frequency counts for occurrence of a particular chronic illness, symptom, or disease. The statistical methodology used was designed to determine if any significant changes in the frequency of occurrence were noticed between the baseline (pre-operational) period and the operational (post-operational) period. In addition, any increase in incidence must be related to the distance of the household to the Egan plant, if the sewage treatment plant is to be implicated as a potential health hazard.

A multiple approach was used to evaluate the health data. First, a contingency table was constructed with factors of survey period at two levels (baseline and operational) and distance at three levels (0-2.0 km, 2.0-3.5 km, and 3.5-5.0 km). A chi-square test of independence was then used to determine if these factors were related in some fashion. The null hypothesis is that incidence bears the same relationship to distance in both years. Rejection of the null hypothesis indicates that the pattern of occurrence of a particular illness or symptom may be dependent upon the survey period and distance from the plant where the data was taken. The test statistic is compared against a chi-square distribution with (2-1)(3-1) = 2 df to determine significance.

There can be a problem in interpreting the results of the chi-square test if the number of individuals in each category (i.e., survey period-distance combination) varies. For this reason, the chi-square test is only used as a first indication of potential changes.

To further evaluate the test results, the relative frequency of occurrence of each symptom is used in a pre- vs post-comparison. The test statistic for this comparison is a standard normal deviate, calculated to test the hypothesis of equivalent proportions in the two surveys in the same distance range. The test statistic is calculated according to the formula

$$Z_0 = \frac{\hat{p}_2 - \hat{p}_1}{\sqrt{\hat{p}(1-\hat{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

where

$\hat{p}_1$ - relative frequency of occurrence in period 1,

$\hat{p}_2$ - relative frequency of occurrence in period 2,

n_1 - number of individuals in period 1,

n_2 - number of individuals in period 2, and

$\hat{p} = (n_1\hat{p}_1 + n_2\hat{p}_2)/(n_1 + n_2)$, relative frequency under the null hypothesis

The same test was used for the relative frequencies for the three distances separately to determine if any change in incidence had a distance pattern consistent with the hypothesis of a plant effect on community health. Test statistics Z_1, Z_2, and Z_3 were calculated corresponding to the three distance ranges studied: (1) 0-2.0 km; (2) 2.0-3.5 km; and (3) 3.5-5.0 km. These statistics, then, test the hypothesis of no change in the relative frequency of occurrence of the illness, disease, or symptom at each distance and are compared to the corresponding Z_0 for consistency.

To evaluate the results of these analyses, the illnesses, diseases, or symptoms with a significant chi-square value were first investigated. For these health parameters, the Z_0 test statistic was used to indicate if an overall trend existed in the surveyed area and if so whether it was for increased or decreased incidence. If a significant trend existed overall, then the individual Z_i were investigated to determine if there was a pattern within the distance levels which differed from the overall trend. If the distance pattern showed a greater increase close to the plant than at the greater distances for any parameter, it was selected for additional analysis as one which may have been affected by the operation of the treatment plant. These patterns of increased incidence were then further investigated to determine if other differences, such as age or sex, could have affected the results.

Since there were unequal sample sizes between the two surveys, it was possible for a significant relationship to exist with distance which did not show a significant survey-distance relationship in the chi-square test. To account for this, the data were investigated to determine if the distance pattern indicated by the Z_i described above existed for any of the remaining illnesses, diseases, or symptoms.

The list of illnesses and symptoms on the questionnaire is fairly comprehensive. As a result, items are included for which no relationship of the treatment plant operation to increased incidence would be expected. The illnesses, diseases, and symptoms were evaluated by a physician prior to the data analysis and this evaluation used in the interpretation of the results. Each of the 60 parameters were denoted as to whether an increase in incidence might plausibly be related to a nearby sewage treatment plant operation. In addition, the age group for which the highest incidence of the disease or symptom would be expected was also evaluated. The difference in the age distributions between the two groups are then accounted for by comparing the expected change in incidence relative to the difference in numbers surveyed of the age group most likely to have a high incidence of the illness, disease, or symptom.

The location of the increase in incidence of any of these diseases or symptoms is also important in assessing whether a treatment plant effect occurred. If increased incidence is related to the treatment plant operation, then the pattern of increased incidence should fall on the predominant directions of wind across the plant. These were determined to be north and south of the plant, and the incidence with distance in these two directions were investigated for those illnesses, diseases, or symptoms which have been determined by prior analyses to be possibly indicative of a sewage treatment plant effect on the general health.

Finally, the illnesses, diseases, and symptoms exhibiting significant pattern and potential relationship to the sewage treatment plant operation were considered together to evaluate the survey's sewage treatment plant health implications. Related symptoms and diseases would be expected to have similar incidence patterns.

Incidence of Illnesses, Diseases, and Symptoms–

The number and relative frequency of positive responses to the 60 chronic illnesses, diseases, and symptoms are shown in Table 69. The responses are categorized by distance and by survey period relative to the number of individuals at that distance range. Shown at the top of the table is the distribution of the individuals (household members) into the three distance categories. The total number of individuals upon whom information was obtained was 4412 in the baseline survey and 4257 in the operational survey.

From the tables, the tendency is observed for a decrease in the percentage incidence of the majority of the illnesses and symptoms. Exceptions to this included influenza, skin disease, diarrhea, general weakness, pain in chest on deep breathing, skin rash: face, and vomiting, which had notably higher percenta.ge incidences in the operational survey at the 0-2.0 km distances.

Statistical Analysis–

The statistics calculated for testing the hypothesis of no sewage treatment plant effect are shown in Table 70. Using the chi-squared statistic, the incidence of the following parameters was determined to exhibit a significant interaction or dependence between distance and survey period at the one percent level: asthma-hay fever; influenza; worms; and vomiting. Significant at the five percent level were: dysentery; general weakness; nausea; and sore throat.

As mentioned above, the illnesses and symptoms were reviewed by a physician for relationship to a treatment plant and for age group expected to have the highest incidence. The summary of this review is shown as Table 71. Using this guideline, asthma-hay fever was eliminated from further consideration as having no relationship to the operation of the treatment plant. Worms was considered a questionable disease, and for the remainder, the judgment was made that changes in their incidence could result from sewage treatment plant operation in a populated area.

To investigate these, then, the differences in their relative incidence were investigated using the standard normal deviates, Z_i, discussed above and shown in Table 70. For a possible effect to be judged, the difference at the 0-2.0 km range should be more strongly positive than at the remainder of distances and from the overall trend for the area under study.

TABLE 69. INCIDENCE OF ILLNESSES, DISEASES, AND SYMPTOMS REPORTED IN THE HOUSEHOLD HEALTH SURVEYS

	Baseline Survey		Operational Survey	
	Number of Responses N		Number of Responses N	
Household Members Surveyed				
0.0 - 2.0 km	750		644	
2.0 - 3.5 km	1711		1621	
3.5 - 5.0 km	1951		1992	
	Positive Responses n	Percentage Incidence p	Positive Responses n	Percentage Incidence p
CHRONIC ILLNESSES EVER DIAGNOSED				
Arthritis and Rheumatism				
0.0 - 2.0 km	33	4.4%	25	3.9%
2.0 - 3.5 km	69	4.0%	57	3.5%
3.5 - 5.0 km	91	4.7%	70	3.5%
Asthma - Hay Fever				
0.0 - 2.0 km	102	13.6%	72	11.2%
2.0 - 3.5 km	188	11.0%	182	11.2%
3.5 - 5.0 km	176	9.0%	235	11.8%
Chronic Sinusitis and Bronchitis				
0.0 - 2.0 km	78	10.4%	47	7.3%
2.0 - 3.5 km	131	7.7%	139	8.6%
3.5 - 5.0 km	175	9.0%	145	7.3%
Diabetes				
0.0 - 2.0 km	9	1.2%	4	0.6%
2.0 - 3.5 km	23	1.3%	19	1.2%
3.5 - 5.0 km	24	1.2%	28	1.4%
Heart Conditions				
0.0 - 2.0 km	8	1.1%	9	1.4%
2.0 - 3.5 km	31	1.8%	28	1.7%
3.5 - 5.0 km	27	1.4%	39	2.0%
Hypertension				
0.0 - 2.0 km	27	3.6%	19	3.0%
2.0 - 3.5 km	48	2.8%	44	2.7%
3.5 - 5.0 km	69	3.5%	82	4.1%
Kidney Disease				
0.0 - 2.0 km	6	0.8%	4	0.6%
2.0 - 3.5 km	12	0.7%	10	0.6%
3.5 - 5.0 km	16	0.8%	19	1.0%
Liver Disease				
0.0 - 2.0 km	3	0.4%	5	0.8%
2.0 - 3.5 km	5	0.3%	6	0.4%
3.5 - 5.0 km	4	0.2%	2	0.1%

(continued)

TABLE 69. (continued)

	Baseline Survey		Operational Survey	
	Positive Responses n	Percentage Incidence p	Positive Responses n	Percentage Incidence p
Malignancies				
0.0 - 2.0 km	8	1.1%	2	0.3%
2.0 - 3.5 km	3	0.2%	5	0.3%
3.5 - 5.0 km	14	0.8%	11	0.6%
Rheumatic Heart Disease				
0.0 - 2.0 km	7	0.9%	5	0.8%
2.0 - 3.5 km	8	0.5%	10	0.6%
3.5 - 5.0 km	14	0.7%	12	0.6%
Thyroid Disease				
0.0 - 2.0 km	12	1.6%	9	1.4%
2.0 0 3.5 km	38	2.2%	22	1.4%
3.5 - 5.0 km	17	0.9%	18	0.9%
Tuberculosis				
0.0 - 2.0 km	2	0.3%	3	0.5%
2.0 - 3.5 km	8	0.5%	3	0.2%
3.5 - 5.0 km	2	0.1%	3	0.2%
DISEASES DIAGNOSED DURING PAST YEAR				
Anemia				
0.0 - 2.0 km	12	1.6%	5	0.8%
2.0 - 3.5 km	19	1.1%	11	0.7%
3.5 - 5.0 km	24	0.7%	21	1.1%
Croup				
0.0 - 2.0 km	14	1.9%	10	1.6%
2.0 - 3.5 km	28	1.6%	13	0.8%
3.5 - 5.0 km	21	1.1%	24	1.2%
Dysentery				
0.0 - 2.0 km	2	0.3%	3	0.5%
2.0 - 3.5 km	22	1.3%	1	0.1%
3.5 - 5.0 km	13	0.7%	7	0.4%
Empyema				
0.0 - 2.0 km	0	0.0%	0	0.0%
2.0 - 3.5 km	2	0.1%	1	0.1%
3.5 - 5.0 km	3	0.2%	0	0.0%
Infectious Jaundice				
0.0 - 2.0 km	1	0.1%	0	0.0%
2.0 - 3.5 km	3	0.2%	1	0.1%
3.5 - 5.0 km	1	0.1%	2	0.1%
Influenza				
0.0 - 2.0 km	70	9.3%	72	11.2%
2.0 - 3.5 km	221	12.9%	122	7.6%
3.5 - 5.0 km	366	18.8%	182	9.1%

(continued)

TABLE 69. (continued)

	Baseline Survey		Operational Survey	
	Positive Responses n	Percentage Incidence p	Positive Responses n	Percentage Incidence p
Pleurisy				
0.0 - 2.0 km	2	0.3%	2	0.3%
2.0 - 3.5 km	11	0.6%	5	0.3%
3.5 - 5.0 km	8	0.4%	2	0.1%
Pneumonia				
0.0 - 2.0 km	10	1.3%	5	0.8%
2.0 - 3.5 km	28	1.6%	20	1.2%
3.5 - 5.0 km	26	1.4%	31	1.6%
Polio				
0.0 - 2.0 km	0	0.0%	0	0.0%
2.0 - 3.5 km	2	0.1%	0	0.0%
3.5 - 5.0 km	0	0.0%	0	0.0%
Skin Disease				
0.0 - 2.0 km	4	0.5%	11	1.7%
2.0 - 3.5 km	28	1.6%	21	1.3%
3.5 - 5.0 km	27	1.4%	27	1.4%
Sleeping Sicknesses				
0.0 - 2.0 km	0	0.0%	0	0.0%
2.0 - 3.5 km	3	0.2%	0	0.0%
3.5 - 5.0 km	1	0.1%	0	0.0%
Spinal Meningitis				
0.0 - 2.0 km	0	0.0%	0	0.0%
2.0 - 3.5 km	2	0.1%	1	0.1%
3.5 - 5.0 km	3	0.2%	5	0.3%
Worms				
0.0 - 2.0 km	7	0.9%	0	0.0%
2.0 - 3.5 km	27	1.6%	0	0.0%
3.5 - 5.0 km	11	0.6%	14	0.7%
SYMPTOMS EXPERIENCED IN PAST 3 MONTHS				
Bloody Diarrhea				
0.0 - 2.0 km	0	0.0%	2	0.3%
2.0 - 3.5 km	2	0.1%	3	0.2%
3.5 - 5.0 km	2	0.1%	5	0.3%
Bloody Urine				
0.0 - 2.0 km	3	0.4%	0	0.0%
2.0 - 3.5 km	1	0.1%	4	0.2%
3.5 - 5.0 km	3	0.2%	3	0.2%

(continued)

TABLE 69. (continued)

	Baseline Survey		Operational Survey	
	Positive Responses n	Percentage Incidence p	Positive Responses n	Percentage Incidence p
Brown Urine				
0.0 - 2.0 km	0	0.0%	0	0.0%
2.0 - 3.5 km	0	0.0%	0	0.0%
3.5 - 5.0 km	2	0.1%	0	0.0%
Burning on Urination				
0.0 - 2.0 km	6	0.8%	6	0.9%
2.0 - 3.5 km	14	0.8%	8	0.5%
3.5 - 5.0 km	14	0.7%	16	0.8%
Canker Sores Around Mouth				
0.0 - 2.0 km	21	2.8%	26	4.0%
2.0 - 3.5 km	39	2.3%	38	2.3%
3.5 - 5.0 km	71	3.6%	49	2.5%
Cold				
0.0 - 2.0 km	238	31.7%	182	28.3%
2.0 - 3.5 km	451	26.4%	395	24.4%
3.5 - 5.0 km	493	25.3%	474	23.8%
Colicky Pains in Abdomen				
0.0 - 2.0 km	9	1.2%	13	2.0%
2.0 - 3.5 km	8	0.5%	11	0.7%
3.5 - 5.0 km	17	0.9%	13	0.7%
Convulsions				
0.0 - 2.0 km	0	0.0%	0	0.0%
2.0 - 3.5 km	2	0.1%	0	0.0%
3.5 - 5.0 km	2	0.1%	1	0.1%
Cough				
0.0 - 2.0 km	143	19.1%	120	18.6%
2.0 - 3.5 km	314	18.4%	228	14.1%
3.5 - 5.0 km	293	15.0%	268	13.5%
Cough up Blood				
0.0 - 2.0 km	0	0.0%	2	0.3%
2.0 - 3.5 km	0	0.0%	2	0.1%
3.5 - 5.0 km	1	0.1%	3	0.2%
Diarrhea				
0.0 - 2.0 km	31	4.1%	49	7.6%
2.0 - 3.5 km	73	4.3%	77	4.8%
3.5 - 5.0 km	94	4.8%	85	4.3%
Draining Ear				
0.0 - 2.0 km	8	1.1%	4	0.6%
2.0 - 3.5 km	8	0.5%	17	1.0%
3.5 - 5.0 km	20	1.0%	19	1.0%

(continued)

TABLE 69. (continued)

	Baseline Survey		Operational Survey	
	Positive Responses n	Percentage Incidence p	Positive Responses n	Percentage Incidence p
Fever above 103°F				
0.0 - 2.0 km	34	4.5%	13	2.0%
2.0 - 3.5 km	33	1.9%	29	1.8%
3.5 - 5.0 km	59	3.0%	24	1.2%
General Weakness				
0.0 - 2.0 km	5	0.7%	12	1.9%
2.0 - 3.5 km	17	1.0%	7	0.4%
3.5 - 5.0 km	29	1.5%	11	0.6%
Hemorrhagic Rash				
0.0 - 2.0 km	0	0.0%	0	0.0%
2.0 - 3.5 km	0	0.0%	2	0.1%
3.5 - 5.0 km	0	0.0%	2	0.1%
Nausea				
0.0 - 2.0 km	9	1.2%	19	3.0%
2.0 - 3.5 km	41	2.4%	23	1.4%
3.5 - 5.0 km	59	3.0%	33	1.7%
Pain in Chest on Deep Breathing				
0.0 - 2.0 km	4	0.5%	12	1.9%
2.0 - 3.5 km	27	1.6%	24	1.5%
3.5 - 5.0 km	28	1.4%	22	1.1%
Severe Dizziness				
0.0 - 2.0 km	7	0.9%	3	0.5%
2.0 - 3.5 km	7	0.4%	14	0.9%
3.5 - 5.0 km	21	1.1%	14	0.7%
Severe Headache not Relieved by Aspirin				
0.0 - 2.0 km	34	4.5%	24	3.7%
2.0 - 3.5 km	71	4.1%	65	4.0%
3.5 - 5.0 km	99	5.1%	72	3.6%
Severe Night Sweats				
0.0 - 2.0 km	5	0.7%	4	0.6%
2.0 - 3.5 km	10	0.6%	8	0.5%
3.5 - 5.0 km	8	0.4%	9	0.5%
Severe Pain in Bones and Joints with High Fever				
0.0 - 2.0 km	8	1.1%	6	0.9%
2.0 - 3.5 km	9	0.5%	16	1.0%
3.5 - 5.0 km	15	0.8%	19	1.0%
Severe Trouble with Teeth				
0.0 - 2.0 km	4	0.5%	5	0.8%
2.0 - 3.5 km	14	0.8%	14	0.9%
3.5 - 5.0 km	26	1.3%	20	1.0%

(continued)

TABLE 69. (continued)

	Baseline Survey		Operational Survey	
	Positive Responses n	Percentage Incidence p	Positive Responses n	Percentage Incidence p
Severe Weight Loss				
0.0 - 2.0 km	3	0.4%	0	0.0%
2.0 - 3.5 km	2	0.1%	2	0.1%
3.5 - 5.0 km	6	0.3%	3	0.2%
Shortness of Breath				
0.0 - 2.0 km	10	1.3%	3	0.5%
2.0 - 3.5 km	16	0.9%	17	1.0%
3.5 - 5.0 km	20	1.0%	18	0.9%
Skin Rash: Arms and Legs				
0.0 - 2.0 km	10	1.3%	8	1.2%
2.0 - 3.5 km	46	2.7%	25	1.5%
3.5 - 5.0 km	52	2.7%	42	2.1%
Skin Rash: Body				
0.0 - 2.0 km	11	1.5%	12	1.9%
2.0 - 3.5 km	30	1.8%	31	1.9%
3.5 - 5.0 km	49	2.5%	33	1.7%
Skin Rash: Face				
0.0 - 2.0 km	3	0.4%	7	1.1%
2.0 - 3.5 km	37	2.2%	25	1.5%
3.5 - 5.0 km	50	2.7%	30	1.5%
Sore Throat				
0.0 - 2.0 km	132	17.6%	59	9.2%
2.0 - 3.5 km	269	15.7%	195	12.0%
3.5 - 5.0 km	333	17.1%	243	12.2%
Stiff Neck with Fever				
0.0 - 2.0 km	4	0.5%	5	0.8%
2.0 - 3.5 km	4	0.2%	4	0.2%
3.5 - 5.0 km	5	0.3%	12	0.6%
Stiff Neck with Rash				
0.0 - 2.0 km	1	0.1%	0	0.0%
2.0 - 3.5 km	0	0.0%	0	0.0%
3.5 - 5.0 km	7	0.4%	4	0.2%
Uncouscious (Not Due to Blow on Head)				
0.0 - 2.0 km	0	0.0%	0	0.0%
2.0 - 3.5 km	4	0.2%	0	0.0%
3.5 - 5.0 km	2	0.1%	0	0.0%
Vomiting				
0.0 - 2.0 km	10	1.3%	20	3.1%
2.0 - 3.5 km	52	3.0%	23	1.4%
3.5 - 5.0 km	53	2.7%	47	2.4%

(continued)

TABLE 69. (continued)

	Baseline Survey		Operational Survey	
	Positive Responses n	Percentage Incidence p	Positive Responses n	Percentage Incidence p
Weakness of Arms or Legs				
0.0 - 2.0 km	10	1.3%	4	0.6%
2.0 - 3.5 km	10	0.6%	10	0.6%
3.5 - 5.0 km	22	1.1%	11	0.6%
Yellow Skin				
0.0 - 2.0 km	0	0.0%	0	0.0%
2.0 - 3.5 km	0	0.0%	0	0.0%
3.5 - 5.0 km	0	0.0%	0	0.0%
Yellow Eyeballs				
0.0 - 2.0 km	1	0.1%	1	0.2%
2.0 - 3.5 km	0	0.0%	1	0.1%
3.5 - 5.0 km	1	0.1%	7	0.4%

TABLE 70. TEST STATISTICS FOR SIGNIFICANCE OF RESPONSES

Illness, Disease or Symptom	Chi-Square	Z_0	Z_1	Z_2	Z_3
		Chronic Illnesses Ever Diagnosed			
Arthritis and Rheumatism	0.11	−1.88	−0.48	−0.78	−1.82
Asthma-Hay Fever	13.19†	1.43	−1.36	0.22	2.85†
Chronic Sinusitis and Bronchitis	6.85	−1.52	−2.02*	0.97	−1.94†
Diabetes	2.38	−0.28	−1.12	−0.45	0.48
Heart Conditions	1.70	1.08	0.56	−0.18	1.40
Hypertension	2.68	0.40	−0.68	−0.16	0.95
Kidney Disease	0.82	0.04	−0.39	−0.30	0.45
Liver Disease	1.22	0.30	0.93	0.39	−0.84
Malignancies	3.41	−0.94	−1.67	0.78	−0.65
Rheumatic Heart Disease	0.64	−0.12	−0.32	0.59	−0.45
Thyroid Disease	1.98	−1.47	−0.31	−1.87	0.11
Tuberculosis	2.29	−0.57	0.62	−1.42	0.42
		Diseases Diagnosed During Past Year			
Anemia	1.76	−1.70	−1.40	−1.32	−0.57
Croup	4.11	−1.33	−0.45	−2.18	0.38
Dysentery	10.03*	−3.63	0.62	−4.27	−1.39
Emphysema	1.20	−1.59	0.00	−0.53	−1.75
Infectious Jaundice	1.96	−0.65	−0.93	−0.95	0.56
Influenza	15.06†	−8.64	1.14	−5.12	−8.73
Pleurisy	1.25	−2.09	0.15	−1.40	−1.93
Pneumonia	2.35	−0.69	−1.00	−0.98	0.31
Polio	0.00	−1.39	0.00	−1.38	0.00
Skin Disease	4.27	0.22	2.12*	−0.82	−0.08
Sleeping Sickness	0.00	−1.96*	0.00	−1.69	−1.01
Spinal Meningitis	0.75	0.37	0.00	−0.53	0.68
Worms	24.96†	−3.90†	−2.46†	−5.08†	0.55
		Symptoms Experienced In Past 3 Months			
Bloody Diarrhea	1.12	1.68	1.52	0.51	1.11
Bloody Urine	4.80	0.07	−1.61	1.40	−0.03
Brown Urine	0.00	−1.39	0.00	0.00	−1.43
Burning on Urination	1.53	−0.34	0.27	−1.17	0.31
Canker Sores Around Mouth	3.27	−0.86	1.28	0.12	−2.16*
Cold	3.88	−2.14*	−1.41	−1.32	−1.08
Colicky Pains in Abdomen	1.61	0.52	1.22	0.81	−0.79
Convulsions	0.83	−1.30	0.00	−1.38	−0.60
Cough	3.66	−3.16†	−0.21	−3.35†	−1.41
Cough Up Blood	1.14	2.18	1.53	1.45	0.98
Diarrhea	4.20	1.07	2.78*	0.67	−0.83
Draining Ear	4.40	0.63	−0.90	1.94	−0.23
Fever Above 103° F	6.26	−4.10†	−2.59†	−0.30	−3.98†
General Weakness	10.40*	−2.17*	2.03*	−1.92	−2.93†
Hemorrhagic Rash	0.00	2.04*	0.00	1.45	1.40
Nausea	10.04*	−2.26*	2.32*	−2.05*	−2.84†
Pain Chest on Deep Breathing	4.89	0.12	2.32*	−0.23	−0.93
Severe Dizziness	5.11	−0.33	−1.03	1.66	−1.25
Severe Headache Not Relieved by Aspirin	1.20	−1.92	−0.75	−0.20	−0.25

*Significant at 0.05 level. Required: X^2 - 7.84, Z - 1.96.
†Significant at 0.01 level. Required: X^2 - 11.34, Z - 2.58.

(continued)

TABLE 70. (continued)

Illness, Disease or Symptom	Chi-Square	Z_0	Z_1	Z_2	Z_3
Symptoms Experienced in Past 3 Months (Cont'd)					
Severe Night Sweats	0.30	−0.17	−0.11	−0.36	0.20
Severe Pain in Bones and Joints with High Fever	1.63	1.23	−0.25	1.54	0.63
Severe Trouble with Teeth	0.59	−0.37	0.56	0.14	−0.96
Severe Weight Loss	2.04	−1.42	−1.61	0.05	−1.03
Shortness of Breath	3.17	−0.70	−1.68	0.33	−0.39
Skin Rash: Arms and Legs	1.60	−2.20*	−0.15	−2.29	−1.15
Skin Rash: Body	2.02	−0.84	0.58	0.34	−1.88
Skin Rash: Face	3.90	−2.05*	1.52	−1.32	−2.35
Sore Throat	8.45*	−6.55†	−4.57†	−3.08†	−4.33†
Stiff Neck with Fever	1.18	1.49	0.56	0.08	1.66
Stiff Neck with Rash	0.55	−1.09	−0.93	0.00	−0.94
Unconsciousness (Not Due to Blow on Head)	0.00	−2.40	0.00	−1.95	−1.43
Vomiting	12.04†	−1.48	2.27*	−3.15†	−0.71
Weakness of Arms or Legs	2.06	−1.92	−1.33	0.12	−1.98
Yellow Skin	0.00	0.00	0.00	0.00	0.00
Yellow Eyeballs	1.76	2.18	0.11	1.03	2.09*

*Significant at 0.05 level. Required: X^2 - 7.84, Z - 1.96.

†Significant at 0.01 level. Required: X^2 - 11.34, Z - 2.58.

TABLE 71. PHYSICIAN'S EVALUATION OF RESPONSE CATEGORIES

Illness, Disease, or Symptom	Expected Sewage Treatment Plant Effect	For Expected Effects, Age Group with Highest Incidence
Chronic Illnesses Ever Diagnosed		
Arthritis and Rheumatism	No	–
Asthma-Hay Fever	No	–
Chronic Sinusitis and Bronchitis	Yes	None
Diabetes	No	–
Heart Conditions (Too Broad)	No	–
Hypertension	No	–
Kidney Disease	Yes	20-50
Liver Disease	Yes	20-40
Malignancies	No	–
Rheumatic Heart Disease	Yes	Below 20
Thyroid Disease	No	–
Tuberculosis	Yes	None

(continued)

TABLE 71. (continued)

Illness, Disease, or Symptom	Expected Sewage Treatment Plant Effect	For Expected Effects, Age Group with Highest Incidence
Diseases Diagnosed During Past Year		
Anemia	No	–
Croup	Yes	Young children
Dysentery	Yes	Children
Emphysema	Possible	–
Infectious Jaundice	Yes	20-40
Influenza	Yes	None
Pleurisy	Possible	–
Pneumonia	Yes	Infants and elderly
Polio	Yes	Infants
Skin Disease	Possible	None
Sleeping Sickness	No	20-30
Spinal Meningitis	Yes	0-20
Worms	Possible	Children
Symptoms Experienced in Past 3 Months		
Bloody Diarrhea	Yes	None
Bloody Urine	Possible	None
Brown Urine	Yes	None
Burning on Urination	No	–
Canker Sores Around Mouth	Yes	None
Cold	Yes	None
Colicky Pains in Abdomen	No	–
Convulsions	Possible (if related to high fever)	None
Cough	Yes	None
Cough Up Blood	Yes (infections)	None
Diarrhea	Yes	Children
Draining Ear	Yes	Children
Fever Above 103° F	Yes	Children
General Weakness	Yes	None
Hemorrhagic Rash	Possible	None
Nausea	Yes	Children
Pain in Chest on Deep Breathing	Possible	–
Severe Dizziness	Yes	20-30
Severe Headache Not Relieved by Aspirin	No	–
Severe Night Sweats	Yes	20-30
Severe Pain in Bones and Joints with High Fever	Yes	None
Severe Trouble with Teeth	No	–
Severe Weight Loss	Possible	None
Shortness of Breath	No	–
Skin Rash: Arms and Legs	Possible	None
Skin Rash: Body	Possible	None
Skin Rash: Face	Possible	None
Sore Throat	Yes	Children
Stiff Neck with Fever	Yes	Children
Stiff Neck with Rash	Yes	Children
Unconsciousness (Not Due to	Yes	None

(continued)

TABLE 71. (continued)

Illness, Disease, or Symptom	Expected Sewage Treatment Plant Effect	For Expected Effects, Age Group with Highest Incidence
Symptoms Experienced in Past 3 Months (Cont'd)		
Blow on Head		
Vomiting	Yes	Children
Weakness of Arms or Legs (Possible)	No	—
Yellow Skin	Yes	None
Yellow Eyeballs	Yes	None

For influenza the nearest distance results were different from the remainder. The overall relative incidence of influenza decreased significantly from the baseline to the operational period, but the decrease was a result of the decrease at the 2.0 to 3.5 and 3.5 to 5.0 km ranges. At the 0-2.0 km distance there was an increase in relative frequency of influenza, although not large enough for significance. The difference between the two surveys was 1.9 percent (11.2-9.3), as shown in Table 69 above.

The responses for worms do not exhibit the pattern indicating a relationship to the sewage treatment plant. There was a decrease overall and at the two closest distances, all with significance levels less than one percent.

The responses to the symptom of vomiting show potential results of the treatment plant operation. The overall trend was for a decrease in percentage incidence, although the calculated test statistic did not achieve significance. There was a significant increase at the 0-2.0 km range, however, with a significance level of less than five percent. The next distance level, 2.0 to 3.5 km, showed a significant decrease, however, and the remaining level had an insignificant decrease. The difference in the percentage incidence at the closest distance was 1.8 percent (3.1-1.3).

For the dysentery responses, a decrease was noted in the overall percentage incidence as well as in the 2.0 to 3.5 km and 3.5 to 5.0 km ranges. At the 0-2.0 km distance, however, a slight increase was noted. From the data tables, this change was from 0.3 percent to 0.5 percent, and represented an increase from 2 to 3 positive responses.

The responses for general weakness showed a strong pattern suggestive of a sewage treatment plant influence. All the calculated statistics were significant, with the overall and the two greatest distances showing a significant decrease in the operational period over the baseline. The 0-2.0 km data, however, showed a significant increase between the two periods. The percentage incidence increased 1.2 percent (0.7 to 1.9) from the baseline to the operational period.

An identical pattern was seen for the nausea responses. The test statistics for the overall area and for the 2.0 to 3.5 and 3.5 to 5.0 km ranges exceed the tabled value for the five percent significance level and indicate decreases in relative frequency of response. The closest range, however, had a significant increase in percentage incidence, going from 1.2 to 3.0 percent.

The final response, for sore throat, gave no indication of a treatment plant effect, since all four of the calculated statistics show a decrease significant beyond the one percent level. The significance of the chi-squared statistic in the instance represents a difference only in the relative magnitude of the decrease, with the largest decrease seen at the 0 to 2.0 km range.

As noted in the methodology section, the chi-squared values are first indications of a change, and may in some instances be influenced by the differences in sample size between the two survey groups. The Z_i are further investigated to determine if a distance pattern of the type noted above exists for any of the illnesses or symptoms which had insignificant chi-square tests. One disease and two symptoms satisfied this criterion: skin disease, diarrhea, and pain in chest on deep breathing.

The responses for skin disease showed a significant increase at the 0 to 2.0 km range, with no change in the relative frequency noted for the overall area or for the two greater distances. The difference in the percentage incidence was from 0.5 to 1.7 percent of the responses.

A similar pattern was observed for diarrhea. The test statistic for the closest distance was significant at the one percent level, while the 2.0 to 3.5 km data showed an insignificant increase and the 3.5 to 5.0 km data indicated an insignificant increase in relative incidence. The change in percentage incidence was 3.5 percent (7.6-4.1).

Finally, pain in chest on deep breathing responses showed a higher percentage incidence in the operational period, significant at the five percent level, at the 0 to 2.0 km range with decreasing frequency, although insignificant, at the remaining distances. The percentage incidence for the individuals closest to the plant rose from 0.5 to 1.9 percent. It should be noted, however, that the physician's evaluation of this symptom indicated only a possible relationship to the operation of the sewage treatment plant.

For those symptoms for which a possible effect was indicated, the number of positive responses and the percentage incidence was determined along the four major wind directions. Two distance levels were used for this portion of the analysis, 0 to 3.5 km and 3.5 to 5.0 km. The sectors as shown on the area map were classified as to principal direction from the plant and are shown in Table 72 along with the responses and percentage incidences. The wind direction for this area as shown in Figure 12 tended to be from either the north or the south for the period of the study, and the relative frequency in the operational period compared to the baseline is evaluated on these two directions. However, since the wind can be from any direction over a period of time, direction relationships cannot be given much weight.

The influenza results show a decrease at both distances for incidence on the north side, but an increase on the south side at the closer distance. The increased percentage incidence was 3.1 percent (15.1-12.0) while for the greater distance, there was a marked decrease from baseline to operational in the south. The data for the north show a decrease, but it should be noted that the earlier investigation separated the 0 to 2.0 km and 2.0 to 3.5 km data. There was a marked decrease in the 2.0 to 3.5 km range in that comparison, and the data here may be somewhat confounded because of that.

The responses for vomitting show an increase at both distances on the north side of the Egan plant and an increase on the south side for the closer distance. The two remaining directions showed decreased percentage incidence at the 0 to 3.5 km range, and the percentage incidence at the greater distance decreased markedly for the south data.

No pattern was evident for dysentery for which, as noted above, the frequency of occurrence at the clos distances was small. The responses at the closer distance were balanced over the four directions.

Responses to general weakness may indicate a directional effect. There was a decrease in relative frequency in all directions at the 3.5 to 5.0 km range from the baseline to the operational period. The close-in data, however, showed an increase on both the north and south sides, of 0.4 percent and 0.5 percent, respectively.

TABLE 72. INCIDENCE BY DISTANCE AND DIRECTION FROM THE EGAN PLANT FOR THOSE DISEASES AND SYMPTOMS WITH A POTENTIALLY IMPLICATING DISTANCE PATTERN

	Baseline Survey		Operational Survey	
	Number of Responses	Included Sectors	Number of Responses	Included Sectors
Household Members Surveyed				
0.0-3.5 km				
North	410	1, 11, Lex. Green	452	1, 11, Lex. Green
East	476	2, 3	375	2, 3
South	750	4, 5, 6	595	4, 5, 6
West	825	7, 8, 9, 10	843	7, 8, 9, 10
3.5-5.0 km				
North	304	12, 21	366	12, 21
East	513	13, 14, 15	623	13, 14, 15
South	394	16, 17	361	16, 17
West	756	18, 19, 20	642	18, 19, 20
	Positive Responses	Percentage Incidence	Positive Responses	Percentage Incidence
Diseases Diagnosed During Past Year				
Dysentery				
0.0-3.5 km				
North	1	0.2	1	0.2
East	17	3.6	0	0.0
South	6	0.8	1	0.2
West	0	0.0	2	0.2
3.5-5.0 km				
North	0	0.0	4	1.1
East	6	1.2	1	0.2
South	4	1.0	1	0.3
West	3	0.4	1	0.2
Influenza				
0.0-3.5 km				
North	41	10.0	32	7.1
East	89	18.7	22	5.9
South	90	12.0	90	15.1
West	71	8.6	50	5.9
3.5-5.0 km				
North	71	23.4	32	8.7
East	84	16.4	71	11.4
South	71	18.0	22	6.1
West	141	18.7	57	8.9
Skin Disease				
0.0-3.5 km				
North	3	0.7	6	1.3
East	14	2.9	6	1.6
South	2	0.3	10	1.7
West	13	1.6	10	1.2

(continued)

TABLE 72. (continued)

	Baseline Survey		Operational Survey	
	Positive Responses	Percentage Incidence	Positive Responses	Percentage Incidence
		Skin Disease (Cont'd)		
3.5-5.0 km				
North	4	1.3	3	0.8
East	3	0.6	11	1.8
South	3	0.8	1	0.3
West	18	2.4	12	1.9
		Symptoms Experienced in Past 3 Months		
		Diarrhea		
0.0-3.5 km				
North	16	3.9	31	6.9
East	36	7.6	11	2.9
South	25	3.3	49	8.2
West	27	3.3	35	4.2
3.5-5.0 km				
North	11	3.6	24	6.6
East	15	2.9	26	4.2
South	27	6.9	6	1.7
West	41	5.4	29	4.5
		General Weakness		
0.0-3.5 km				
North	1	0.2	3	0.6
East	10	2.1	1	0.3
South	4	0.5	6	1.0
West	7	0.8	9	1.1
3.5-5.0 km				
North	2	0.7	2	0.5
East	9	1.8	4	0.6
South	3	0.8	1	0.3
West	15	2.0	4	0.6
		Nausea		
0.0-3.5 km				
North	7	1.7	7	1.5
East	15	3.2	3	0.8
South	13	1.7	12	2.0
West	15	1.8	20	2.4
3.5-5.0 km				
North	5	1.6	13	3.6
East	12	2.3	5	0.8
South	12	3.0	2	0.6
West	30	4.0	13	2.0

(continued)

TABLE 72. (continued)

	Baseline Survey		Operational Survey	
	Positive Responses	Percentage Incidence	Positive Responses	Percentage Incidence
Pain in Chest on Deep Breathing				
0.0-3.5 km				
North	3	0.7	8	1.8
East	8	1.7	4	1.1
South	7	0.9	13	2.2
West	13	1.6	11	1.3
3.5-5.0 km				
North	5	1.6	7	1.9
East	3	0.6	5	0.8
South	7	1.8	4	1.1
West	13	1.7	6	0.9
Vomiting				
0.0-3.5 km				
North	8	2.0	13	2.9
East	21	4.4	2	0.5
South	16	2.1	15	2.5
West	17	2.1	13	1.5
3.5-5.0 km				
North	7	2.3	14	3.8
East	7	1.4	15	2.4
South	9	2.3	3	0.8
West	30	4.0	15	2.3

For the responses to nausea, an increase was noted in the relative frequency along the south side and on the west, a slight decrease in the north and a large decrease in the east. At the farther distances, the only increase observed was along the northerly direction. The results for this response may also have been affected by the combining of the two lowest distances used in the incidence analysis, since the 0 to 2.0 km data showed an increase and the 2.0 to 3.5 showed a decrease. The total percentage incidence for nausea at these ranges combined is nearly equal for the two periods as a result.

The responses for skin disease evidence a pattern which may indicate a treatment plant effect. The north and south regions show an increase in percentage incidence at the close distance while the east and west regions show a decrease. At the greater distances, the pattern is reversed, which indicates that the incidence may not be related to the general welfare but may be specific to those narrow regions.

A similar pattern exists at the close range for diarrhea, with increases of 3.0 to 4.9 percentage incidence for the north and south regions, respectively. At the greater distance, there was an increase in the north region, while the south region showed a decreased incidence.

For pain in chest on deep breathing, an almost identical pattern was observed. The increase in percentage incidence for north and south, respectively, were 1.1 and 1.3 for the 0 to 3.5 km data, while the east and west frequency declined. The north region showed an increase at the 3.5 to 5.0 km range, but the percentage incidence in the south declined as before.

The possible effect of age differences on the observed results were considered in view of the fact that the age-distance relationship was shown to be significantly different between the two groups. The age groups determined by the physician to have the highest relative incidence were inspected. Of the nine diseases or symptoms for which a distance effect was noted, children were reported to have the highest relative incidence in five of the cases, no age group in three of the cases, and one (pain in chest on deep breathing) considered not related.

By inspection of the data, if age group differences were to affect the results of the distance investigation, then the higher percentage incidence would be expected in the survey period for which the greater frequency of children at the 0 to 2.0 km range was observed. From the data shown previously in this Section, there was a higher frequency of children at the closest distance during the baseline survey. As a result, the higher frequencies obtained in the operational period were contrary to the change that would be expected based upon age differences between the two groups.

To further investigate the possibility of an age or age-sex effect on the observed results, the percentage incidence by age and sex groups at the closest distance was calculated for each disease and symptom determined to be possibly indicative of a treatment plant effect. These are shown in Tables 73 through 80, and were used to indicate if a particular group was responsible for the increase or if it was evident in all ages and both sexes.

TABLE 73. PERCENTAGE INCIDENCE OF INFLUENZA BY AGE AND SEX GROUP AT 0 TO 2.0 km DISTANCE

Age Group	Percentage Incidence		Percentage Difference
	Baseline Survey	Operational Survey	
	Male		
0-5	11.1	14.6	3.5
6-18	17.1	14.5	−2.6
19-45	6.7	11.8	5.1
46-64	3.6	5.7	2.1
65 +	0.0	0.0	0.0
	Female		
0-5	7.7	16.3	9.3
6-18	7.1	8.3	1.2
19-45	11.2	11.2	0.0
46-64	12.2	5.7	−6.5
65 +	0.0	0.0	0.0

TABLE 74. PERCENTAGE INCIDENCE OF VOMITING BY AGE AND SEX GROUP AT 0 TO 2.0 km DISTANCE

Age Group	Percentage Incidence		Percentage Difference
	Baseline Survey	Operational Survey	
	Male		
0-5	6.2	5.5	−0.7
6-18	0.0	4.8	4.8
19-45	0.0	0.0	0.0
46-64	0.0	2.9	2.9
65+	0.0	0.0	0.0
	Female		
0-5	1.5	6.1	4.6
6-18	1.4	7.1	5.7
19-45	1.1	2.0	0.9
46-64	2.0	0.0	−2.0
65+	0.0	0.0	0.0

TABLE 75. PERCENTAGE INCIDENCE OF DYSENTERY BY AGE AND SEX GROUP AT 0 TO 2.0 km DISTANCE

Age Group	Percentage Incidence		Percentage Difference
	Baseline Survey	Operational Survey	
Male			
0-5	1.2	1.8	0.6
6-18	0.0	1.2	1.2
19-45	0.0	0.0	0.0
46-64	0.0	0.0	0.0
65+	0.0	0.0	0.0
Female			
0-5	1.5	2.0	0.5
6-18	0.0	0.0	0.0
19-45	0.0	0.0	0.0
46-64	0.0	0.0	0.0
65+	0.0	0.0	0.0

TABLE 76. PERCENTAGE INCIDENCE OF GENERAL WEAKNESS BY AGE AND SEX GROUP AT 0 TO 2.0 km DISTANCE

Age Group	Percentage Incidence		Percentage Difference
	Baseline Survey	Operational Survey	
Male			
0-5	0.0	1.8	1.8
6-18	0.0	2.4	2.4
19-45	0.6	2.9	2.3
46-64	0.0	0.0	0.0
65+	0.0	0.0	0.0
Female			
0-5	0.0	0.0	0.0
6-18	0.0	2.4	2.4
19-45	1.1	2.0	0.9
46-64	4.1	0.0	−4.1
65+	0.0	0.0	0.0

TABLE 77. PERCENTAGE INCIDENCE OF NAUSEA BY AGE AND SEX GROUP AT 0 TO 2.0 km DISTANCE

Age Group	Percentage Incidence		Percentage Difference
	Baseline Survey	Operational Survey	
Male			
0-5	2.5	3.6	1.1
6-18	0.0	3.6	3.6
19-45	0.0	2.2	2.2
46-64	0.0	0.0	0.0
65+	0.0	0.0	0.0
Female			
0-5	0.0	0.0	0.0
6-18	2.9	3.6	0.7
19-45	1.7	5.3	3.6
46-64	4.1	0.0	−4.1
65+	0.0	0.0	0.0

TABLE 78. PERCENTAGE INCIDENCE OF SKIN DISEASE BY AGE AND SEX GROUP AT 0 TO 2.0 km DISTANCE

Age Group	Percentage Incidence		Percentage Difference
	Baseline Survey	Operational Survey	
Male			
0-5	0.0	1.8	1.8
6-18	0.0	1.2	1.2
19-45	0.6	1.5	0.9
46-64	0.0	2.9	2.9
65+	0.0	0.0	0.0
Female			
0-5	1.5	2.0	0.5
6-18	0.0	2.4	2.4
19-45	1.1	2.0	0.9
46-64	0.0	0.0	0.0
65+	12.5	0.0	−12.5

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TABLE 79. PERCENTAGE INCIDENCE OF DIARRHEA BY AGE AND SEX GROUP AT 0 TO 2.0 km DISTANCE

Age Group	Percentage Incidence		Percentage Difference
	Baseline Survey	Operational Survey	
Male			
0-5	7.4	14.6	7.2
6-18	5.7	6.0	0.3
19-45	3.4	5.9	2.5
46-64	1.8	5.7	3.9
65+	1.1	0.0	-1.1
Female			
0-5	6.2	16.3	10.1
6-18	4.3	4.8	0.5
19-45	2.2	8.5	6.4
46-64	4.1	2.9	-1.2
65+	0.0	0.0	0.0

TABLE 80. PERCENTAGE INCIDENCE OF PAIN IN CHEST ON DEEP BREATHING BY AGE AND SEX GROUP AT 0 TO 2.0 km DISTANCE

Age Group	Percentage Incidence		Percentage Difference
	Baseline Survey	Operational Survey	
Male			
0-5	0.0	1.8	1.8
6-18	0.0	3.6	3.6
19-45	0.0	2.2	2.2
46-64	0.0	2.9	2.9
65+	11.1	0.0	-11.1
Female			
0-5	0.0	0.0	0.0
6-18	1.4	1.2	0.2
19-45	0.6	2.0	1.4
46-64	2.0	0.0	-2.0
65+	0.0	0.0	0.0

As can be seen, for those diseases and symptoms for which an increase was observed at the 0 to 2.0 km range, the tendency was for this to be irrespective of age or sex group. The increases, indicated by positive differences, occur across both sexes and several age groupings. The implication is, then, that the observed differences between the two periods are not related to the difference in the age or age-sex composition of the two surveys.

Summary--

The summary of findings from the health survey is contained in Table 81. The following observations on the results can be made when considering the entire set of illnesses and symptoms. It was considered that people aware of the purpose of the study might bias their responses to the questionnaire toward the indication of health hazard by, consciously or unconsciously, recalling a higher incidence than they might have otherwise. Although this cannot be ruled out as a possibility, the available evidence from the results does not indicate

TABLE 81. SUMMARY OF HEALTH SURVEY ANALYSES

Illness, Disease, or Symptom	Test for Independence	Physician's Evaluation	Distance Relationship	Direction Relationship
Asthma-Hay Fever	Significant at 0.01	Not related	None	–
Influenza	Significant at 0.01	Related	Slight increase at 0-2, decrease overall	Increase at close distance in south
Worms	Significant at 0.01	Possibly related	None	–
Vomiting	Significant at 0.01	Related	Significant increase 0-2, slight decrease elsewhere	Increase at close distance north and south
Dysentery	Significant at 0.05	Related	Slight increase 0-2, decrease elsewhere	None
General Weakness	Significant at 0.05	Related	Significant increase 0-2, significant decrease elsewhere	Increase at close distance north and south
Nausea	Significant at 0.05	Related	Significant increase 0-2, significant decrease elsewhere	Increase at close distance in south
Sore Throat	Significant at 0.05	Related	None	–
Skin Disease	Not significant	Possibly related	Significant increase 0-2, no change elsewhere	Increase at close distance north and south
Diarrhea	Not significant	Related	Significant increase 0-2, no change elsewhere	Increase at close distance north and south
Pain in Chest on Deep Breathing	Not significant	Not related	Significant increase 0.2, slight decrease elsewhere	Increase at close distance north and south

that this occurred. The health variables studied were not all considered relative to the treatment plant, but only one of the unrelated illnesses, asthma-hay fever, showed a significant value on testing for independence, and one other was selected based on the distance relationship of the standardized normal deviates. If misleading information was being obtained, there would likely be a higher incidence of significant non-related diseases or symptoms.

Secondly, the judgment as to whether a treatment plant effect may have occurred is based on the breakdown of the sample into the three distance groupings. The respondees were not informed of this, however, nor of the group to which they belonged. Thus, people living in the same inner section could be classified as either 0 to 2.0 km or 2.0 to 3.5 km, and if the results differ between these groups, the possibility of a prejudice existing is not as high.

With regard to the diseases and symptoms for which a treatment plant effect may be indicated, there is some consistency when they are considered as a whole. Vomiting, nausea, and diarrhea can be expected to occur together in many instances and should show the same pattern. Dysentery is also related to one or more of the above, as can be influenza.

The directional relationship investigation showed that there was an increase in the south in the inner sectors for all the diseases and symptoms which the prior analyses had labelled as a possible health effect of the treatment plant, and in the north for all but two. These were the two prominent wind directions for the area during the operational period, and the consistency of these results gives some credence to the possibility that the changes in the general health were related to the sewage treatment plant.

For none of the responses did the change appear to be isolated to a single age or sex group which might have occurred because of the differences in the age-sex composition of the two surveys.

HUMAN SUBJECTS CHARACTERISTICS

Human Subject Participation by Sampling Period

Number of Human Subjects–

A total of 231 human subjects were recuited in October 1974 for participation in the study. In addition, with the development of the Lexington Green Apartment complex subsequent to the initiation of the study, an additional 51 participants were recruited from this area alone in October 1975. All of these participants were to continue in the study to its completion and no further participants were recruited. Due to movement of people from the area, some of the 282 participants did not complete the study. The number of participants from whom some clinical specimens were received in each of the five periods is shown in Table 82.

TABLE 82. PARTICIPANTS BY GROUP AND SAMPLING PERIOD

Sampling Period	Original Human Subjects	Additional Human Subjects	Total
October 1974	231	–	231
February 1975	223	–	228
October 1975	–	51	51
February 1976	205	–	205
October 1976	192	34	226

A total of 192 (83 percent) of the original human subjects completed all four sampling periods, and 34 (67 percent) of the additional human subjects completed both of their sampling periods.

Age and Sex Distribution–

The distributions of both the original and the additional human subject participants are summarized in Table 83 for the initial and final sampling periods. Four age classes are used, 0-6, 7-18, 19-45 and 45 and over, and the subjects are summarized by sex. The age was fixed at the time of recruitment so each participant would remain in the same age class throughout the study. Also shown are the percentages relative to the total sample, and these may be compared to the census data in Section 4 for consistency.

TABLE 83. AGE AND SEX DISTRIBUTION OF HUMAN SUBJECT PARTICIPANTS

Age Group	Initial				Final			
	Male		Female		Male		Female	
	No.	%	No.	%	No.	%	No.	%
Original Human Subjects								
0-6	22	9.5	28	12.1	19	9.9	22	11.5
7-18	33	14.3	25	10.8	27	14.1	20	10.4
19-45	40	17.3	52	22.5	33	17.2	43	22.4
46+	15	6.5	16	6.9	13	6.8	15	7.8
TOTAL	110	47.6	121	52.4	92	47.9	100	52.1
Additional Human Subjects								
0-6	1	2.0	7	13.7	1	2.9	4	11.8
7-18	1	2.0	4	7.8	0	0.0	0	0.0
19-45	13	25.5	15	29.4	10	29.4	12	35.3
46+	3	5.9	7	13.7	2	5.9	5	14.7
TOTAL	18	35.3	33	64.7	13	38.2	21	61.8

There was little change in the relative frequency of the age-sex groups from the initial to the final sampling. The differences ranged from 0.1 percent to 0.9 percent, and indicate that both groups were comparable in their overall makeup. There was more variability in the additional participants from initial to final sampling, but this was largely due to the smaller sample size involved.

The balance between male and female participants in the original group was good, while the females predominated in the additional group. For the original subjects, frequency of children was, by design, high relative to the census data, with frequencies in both the 7-18 and 19-45 classes low relative to the census data. For the additional group, the male and female 19-45 classes contained most of the participants, but the Lexington Green area was not considered to be representative of the general area in composition.

Distribution of Participants Sampled in October 1976

The human subjects remaining throughout the study had been questioned during their recruitment at the beginning of the study regarding personal, socioeconomic, medical, and exposure characteristics. The responses to the questionnaire are summarized below for the 226 participants completing the study.

Personal Characteristics--

The age and sex distribution of the participants is summarized above for the October 1976 sampling period. The racial distribution is summarized in Table 84. The participants were predominantly white,

TABLE 84. RACIAL DISTRIBUTION OF HUMAN SUBJECT PARTICIPANTS

Race	Number	Percentage*
Negro	3	1.6
Oriental	4	2.2
White	173	95.6
Other	1	0.6
Unspecified	45	–

*Percent of questionnaires where race indicated.

comprising 96 percent of those participants for whom the race was identified. This is consistent both with the general area, as indicated by the census data, and with the proportions in the household health survey as a whole.

Hair color distribution is summarized in Table 85. The dominant hair colors were brown, with 53 percent, and blonde, with 34 percent. Marital status of the participants is summarized in Table 86. A total of 123, or 54.4 percent, were married, and 96, or 42.5 percent, were single, with the majority of the single individuals resulting from participants under 18 years of age.

TABLE 85. HAIR COLOR DISTRIBUTION OF HUMAN SUBJECT PARTICIPANTS

Color	Number	Percentage*
Brown	120	53.3
Black	14	6.2
Red	5	2.2
Blonde	77	34.2
Gray	9	4.0
Unspecified	1	–

*Excluding unspecified.

TABLE 86. MARITAL STATUS DISTRIBUTION OF HUMAN SUBJECT PARTICIPANTS

Marital Status	Number	Percentage
Single	96	42.5
Married	123	54.4
Divorced	3	1.3
Widowed	4	1.8

There were three questions concerned with the employment of the participants. Each was asked to state their present employment status, their occupation, and the nature of the business of their employer. These results are summarized in Tables 87 through 89. A total of 73 individuals, or 32.3 percent, stated that they were employed full time, with the majority of the remaining individuals classified as students or housewives. Only one was unemployed and two were retired.

TABLE 87. OCCUPATIONAL STATUS DISTRIBUTION OF HUMAN SUBJECT PARTICIPANTS

Occupational Status	Number	Percentage
Employed Full Time	73	32.3
Employed Part Time	14	6.2
Unemployed	1	0.4
Housewife	42	18.6
Student	62	27.4
Play-Nursery School	9	4.0
Pre-School	23	10.2
Retired	2	0.9

TABLE 88. OCCUPATION DISTRIBUTION OF HUMAN SUBJECT PARTICIPANTS

Occupation	Number	Percentage*
Professional	16	8.0
Administrative	13	6.5
Technical	14	7.0
Clerical	12	6.0
Sales	6	3.0
Foreman/Craftsman	7	3.5
Laborer	6	3.0
Student	68	34.2
Volunteer Worker	1	0.5
Waiter/Waitress	1	0.5
Teacher	9	4.5
Housewife	44	22.1
Retired	2	1.0
Other/inappropriate response	27	–

*Excluding Other/Inappropriate

TABLE 89. EMPLOYER DISTRIBUTION OF HUMAN SUBJECT PARTICIPANTS

Description of Employer	Number	Percentage*
Medicine	5	2.7
Public Assistance	3	1.6
Law	1	0.5
Education	64	35.2
Business	34	18.7
Industry	25	13.7
Government	1	0.5
Construction	3	1.6
Research	1	0.5
Retired	2	1.1
Home	43	23.6
Other/inappropriate response	44	–

*Excluding Other/Inappropriate

Professional and administrative classifications accounted for 14.5 percent of the total sample and 33.3 percent of those in full or part time employment. There was no dominant occupation listed. Business and industry dominated the employer distribution with 59 of the participants falling in those two categories. This represents 67.8 percent of the participants listed as employed full or part time.

Socioeconomic Characteristics–

There were two questions relating to the socioeconomic status of the participants. These involved the educational level and the occupation of the head of the household only. There were 90 total households among the 226 participants, and the occupations and frequency of occurrence are shown in Table 90. Forty percent of this group was classified as in either professional or administrative positions, and another 18.9 percent in the technical. The educational levels of the heads of household in Table 91 show that a total of 48.9 percent had college and that 11 percent had attended graduate school. The responses in these two categories indicate that the population being sampled was above average in both education and occupational classifications.

TABLE 90. OCCUPATION OF HEADS OF HOUSEHOLDS

Occupation	Number	Percentage
Professional	18	20.0
Administrative	18	20.0
Technical	17	18.9
Clerical	5	5.6
Sales	8	8.9
Foreman/Craftsman	8	8.9
Laborer	9	10.0
Teacher	5	5.6
Librarian	1	1.1
Retired	1	1.1

TABLE 91. EDUCATIONAL LEVEL OF HEADS OF HOUSEHOLDS

Level	Number	Percentage
8th Grade	1	1.1
High School Incomplete	6	6.7
High School Complete	17	18.9
College Incomplete	22	24.4
College Complete	34	37.8
Graduate School	10	11.1

Medical History–

The participants were questioned regarding their medical history prior to the study. They were asked to state whether they had ever been diagnosed for a number of chronic illnesses, corresponding to those for which information was obtained in the household health survey. The summary of positive responses and percentage incidence of these chronic illnesses prior to the study are shown in Table 92.

The highest percentage incidences were for asthma-hay fever and sinusitis-bronchitis, affecting 17.7 and 11.9 percent of the sample, respectively

Exposure characteristics–

To evaluate the exposure of the individuals both to the Egan plant and to other possible sources of health hazard, the participants were questioned regarding nearness to potential sources, length of residence both at

TABLE 92. FREQUENCY OF CHRONIC ILLNESSES AMONG HUMAN PARTICIPANTS

Prior Diagnosis of Chronic Illness	Number of Positive Responses	Percentage
Tuberculosis	3	1.3
Malignancies	3	1.3
Asthma-Hay Fever	40	17.7
Diabetes	3	1.3
Heart Condition	8	3.5
Hypertension	12	5.3
Sinusitis-Bronchitis	27	11.9
Arthritis-Rheumatism	13	5.8
Rheumatic Heart Disease	2	0.9
Thyroid Disease	7	3.1
Liver Disease	1	0.4
Kidney Disease	2	0.9

their current address and in the same city or town, time spent away from the home, and cigarette smoking habits. In addition, the age and sex of the individual was tabulated with distance from the plant, since certain of the illnesses or diseases potentially arising from sewage treatment plant operation are expected to have higher relative incidence among certain age groups or in a specific sex.

The location of the participants with respect to distance and direction from the Egan plant is summarized in Table 93. The location of each household was determined to the nearest one-tenth kilometer and recorded. The residences then were located within respect to direction from the plant using 36 ten-degree sectors, where the center of sector 36 lay directly north of the center of the treatment plant.

TABLE 93. PARTICIPANTS BY DISTANCE AND DIRECTION FROM EGAN PLANT

Direction	Sector (× 10°)	Distance (km)			
		0.0 to 0.9	1.0 to 1.9	2.0 to 2.9	3.0 +
North	34 to 02	2	3	14	0
Northeast	03 to 06	0	0	0	0
East	07 to 11	0	0	5	0
Southeast	12 to 15	0	4	4	21
South	16 to 20	0	20	15	0
Southwest	21 to 24	0	0	14	9
West	25 to 29	0	8	17	7
Northwest	30 to 33	32	0	44	7

The individuals falling within the 0.0 to 0.9 range actually represent a range of only 0.4 to 0.6 km from the plant, and represent the Lexington Green area. The next closest participants lie at 1.4 km from the plant. The majority of the participants lie on the northwest and south sides of the center of the plant, and the northeast and east sectors combined have only five participants. The predominant wind directions for the area are from the north and south, with winds seldom coming from the east. Thus, the selected participants resided largely in both the high exposure and the low exposure regions.

The exposure of the participants to other sources of potential health hazard was noted by recording the distance from the residence to expressways, multi-lane highways, and industrial operations. The distance from the participants' residences to the nearest expressway is summarized in Table 94.

TABLE 94. DISTANCE FROM NEAREST EXPRESSWAY FOR HUMAN SUBJECT PARTICIPANTS

Distance	Number	Percentage
Less than 2 blocks	2	0.9
2 blocks up to 1 mile	59	26.1
At least 1 mile	165	73.0

There were only two individuals who lived within two blocks of an expressway, with the majority, 73 percent, living one mile or more away. The responses for closeness to multi-lane highways are shown in Table 95.

TABLE 95. DISTANCE FROM NEAREST MULTI-LANE HIGHWAY FOR HUMAN SUBJECT PARTICIPANTS

Distance	Number	Percentage
Less than 2 blocks	22	9.7
2 blocks up to 1 mile	92	40.7
At least 1 mile	112	49.6

There were 22, or 9.7 percent, within two blocks and a higher percentage in the 2 blocks to one mile range. Still about one half of the participants lived one mile or more from this potential source of health hazard. All of the individuals responded that they lived one mile or more from the nearest industry.

The age and sex of the participants is classified for each of the distances from the Egan plant, given in kilometers. The summary is shown in Table 96. There was a fairly uniform frequency of participants at the middle three distance ranges, and there was an adequate representation of individuals at each of the age groups for those three distances.

TABLE 96. AGE - SEX - DISTANCE DISTRIBUTION OF HUMAN SUBJECT PARTICIPANTS

Distance (km)	Age Group								
	0-6		7-18		19-45		46+		
	Male	Female	Male	Female	Male	Female	Male	Female	Total
0-1	1	5			10	12	2	5	35
1-2	6	11	5	2	15	20	4	5	68
2-3	7	3	14	9	5	11	7	6	62
3-4	6	7	8	9	12	11	2	4	59
4-5					1	1			2

The length of residency of the individuals at the time of recruitment is shown in Tables 97 and 98 for first the address and then the city. The majority of the participants, about 60 percent, had been at their present address between one and three years, and only 11 percent less than one year. The residency within the city showed a similar pattern except that the one to three category decreased to about 52 percent.

TABLE 97. YEARS OF RESIDENCY AT PRESENT ADDRESS FOR HUMAN SUBJECT PARTICIPANTS

Years	Number	Percentage
Less than 1	25	11.1
1 to 3	135	59.7
3 or more	66	29.2

TABLE 98. YEARS OF RESIDENCE IN THE CITY FOR HUMAN SUBJECT PARTICIPANTS

Years	Number	Percentage
Less than 1	24	10.6
1 to 3	117	51.8
3 or more	85	37.6

The number of hours spent away from the home was requested to indicate the adequacy of using the residence as the primary measure of exposure. The number of hours per day that the individual could be expected to be more than two miles from home was recorded and is summarized in Table 99. The percentage of participants expected to be away from the home no more than one hour per day was 50.9 percent, while 35 percent were listed as eight hours or more.

TABLE 99. HOURS PER DAY MORE THAN 2 MILES FROM HOME FOR HUMAN SUBJECT PARTICIPANTS

Hours	Number	Percentage
0	90	39.8
1	25	11.1
2	4	1.8
3	8	3.5
4	2	0.9
5	2	0.9
6	10	4.4
7	6	2.7
8	19	8.4
9	17	7.5
10	21	9.3
11	8	3.5
12	8	3.5
13	1	0.4
14	2	0.9
15	3	1.3

Cigarette smoking habits are summarized in Table 100. There were 47 current smokers and 28 former smokers among the participants, while approximately two-thirds of the group were nonsmokers. The definition of a nonsmoker, as previously used, was an individual who had not smoked as many as 100 cigarettes in his lifetime.

TABLE 100. CIGARETTE SMOKING AMONG HUMAN SUBJECT PARTICIPANTS

Status	Number	Percentage
Current Smoker	47	20.8
Former Smoker	28	12.4
Non-Smoker	151	66.8

Comparison to Household Health Data–

The participants were selected from the baseline household health survey and the two groups can be compared for consistency. The heads of household for the participants showed higher educational levels and more professional and administrative occupations than did the baseline survey. Racially, both groups were almost exclusively white.

For exposure characteristics, the participants showed lower exposure to other potential sources of health hazard. The household health data indicated a greater frequency of occurrence of individuals close to expressways and highways, and much more closeness to industrial operations. The participants were all in excess of one mile from the nearest industry.

Distributions of 100 Human Subjects Analyzed for Additional Viral Serology

Summary of Selected Human Subjects and Samples–

Selection of blood samples for this additional study was based on several criteria. First, a sufficient quantity of blood was required for the analyses for two separate samples, October 1974 or 1975, and October 1976, to allow a comparison of before and after for antibody production. The two October samples were selected to minimize any seasonal variability in the blood antibody levels. Three groups of subjects were set up. The first group was composed of the additional participants from the Lexington Green area, since their proximity to the plant gave them the greatest exposure. The second group was obtained from original participants living near the plant (within 2.3 km) in the prevailing downwind directions (north, east, and south). The third group was composed of original participants living farther from the plant in the infrequent downwind directions (west and southwest).

Twenty-eight of the Lexington Green participants had sufficient samples of blood from the two sampling periods to allow the evaluation of antibody production. The remainder of the required participants were selected based on sample availability and on obtaining a similar age-sex distribution to the Lexington Green group. This permitted a more valid comparison between the groups to be made than if the samples were merely chosen on a random basis.

The three groups, Lexington Green, original-close, and original-far, were labeled Groups I, II, and III, respectively. The identification numbers of the participants in these groups are shown in Table 101. The total participants for each group was 28, 39, and 33, respectively.

TABLE 101. SELECTED PARTICIPANTS–
ADDITIONAL SEROLOGICAL TESTS

Group I (Lexington Green)	Group II (original–close)	Group III (original–far)
603	2	49
614	3	50
615	4	74
616	11	75
617	12	76
619	13	83
621	14	84
628	15	97
630	16	101
631	29	102
632	33	141
633	157	143
634	158	145
640	159	146
641	162	284

(continued)

TABLE 101. (continued)

Group I (Lexington Green)	Group II (orignal – close)	Group III (original – far)
642	165	290
643	166	294
644	172	312
645	177	324
646	178	325
647	181	372
648	182	374
649	196	386
650	199	391
651	206	441
652	207	443
653	213	445
654	214	446
	226	457
	227	464
	228	465
	229	504
	231	510
	233	
	241	
	242	
	244	
	260	
	500	

Human Subject Group Distributions–

The characteristics of the participants are summarized in Tables 102 and 103. All members of Group I resided just northwest of the treatment plant, Group II was located primarily south of the plant, and Group III was mainly toward the northwest. For both Groups II and III, however, there was a wide range of directions which were used.

TABLE 102. CHARACTERISTICS OF PARTICIPANT GROUPS

Characteristic	Group I	Group II	Group III
Distance from John Egan Plant Aeration Basins (km)	0.3-0.8	1.4-2.3	2.8-3.5
Predominant Direction from Plant (deg)	348	177	316
Range of Directions (deg)	305-358	95-105 125-135 165-185 345-15	125-145 215-245 265-275 305-325
Presumed Exposure Level	High	Moderate	Low
Number of Participants	28	39	33
Current Smoker Status:			
Yes	10	6	9
No	18	33	24
Air Conditioning:			
None	1	8	10
Window	0	8	15
Central	26	23	8
No Response	1	0	0
Education (head of household):			
8th Grade	0	0	0
HS Incomplete	1	1	3
HS Complete	8	3	7
College Incomplete	4	13	10
College Complete	9	19	9
Graduate School	6	3	4

TABLE 103. AGE AND SEX DISTRIBUTIONS OF PARTICIPANT GROUPS

	Age (yr)	Male	Female	Total
Group I Participants	0-6	0	2	2
(0.3-0.8 km)	7-18	0	0	0
	19-45	9	10	19
	46+	2	5	7
Total		11	17	28
Group II Participants	0-6	2	4	6
(1.4-2.3 km)	7-18	0	0	0
	19-45	8	13	20
	46+	5	7	11
Total		15	22	37
Group III Participants	0-6	3	5	8
(2.8-3.5 km)	7-18	0	0	0
	19-45	9	8	17
	46+	2	6	8
Total		14	19	33

A higher frequency of smokers was observed in Group I and also a higher frequency of central air- conditioning. The frequency of air-conditioning could reduce the effect of the presumed higher exposure levels by removing particles from the air being drawn into the house. Groups II and III, with 21 and 30 percent, respectively, of participants without air-conditioned homes would have greater exposure to any hazard- bearing particles in the air outside the home.

Socioeconomically, the first two groups could be considered equivalent, based on the educational level of the head of the household. In both groups, over 50 percent had completed college with some members attending graduate school.

The age and sex distributions show that equivalent male-female breakdowns were observed in all groups as the percentage of males ranged from 38 percent in Group II to 42 percent in Group III. The breakdown by age shows that all groups were predominantly adults, aged 19-45. There was a greater frequency of children in Groups II and III than in Group I.

CLINICAL SPECIMEN MICROBIOLOGY

Statistical Methodology

The statistical analysis of the clinical specimen microbiology had two major objectives: to determine from the self- and seasonally-paired data whether the occurrence of any of the pathogens analyzed increased in the operational sampling periods, and, if so, to determine whether such increases were related to exposure factors such as distance from the sewage treatment plant, or to other factors such as participant characteristics.

In order to determine whether the occurrence of pathogens in the clinical specimens had increased after the plant began operating, the analytical results of the samples taken from each participant were matched according to season (February or October) and compared for each of the bacteria, parasites and viruses analyzed in the four sample media (feces, throat swabs, sputum, and blood). The comparison of the paired isolation results from bacterial, parasitic, or viral analyses of feces, throat swab, or sputum samples yielded only three possible outcomes, which were coded as —, 0, and + :

— the pathogen was isolated in the baseline period sample, but was not isolated in the paired operational period sample;

0 the paired baseline and operational period samples both contained the pathogen or both were negative for the pathogen; and

+ the pathogen was isolated in the operational period sample, but not in the baseline period sample.

Only paired samples showing a change, either an increase or decrease, over the two sets of sampling periods were statistically analyzed; incomplete pairs were deleted. The resulting data were evaluated through a series of sign tests, using two-sided levels of significance, to test the null hypothesis of no difference between the frequency of pathogen isolations reported for the baseline and operational sampling periods. For those microbiological analyses in which the number of pairs showing a change was greater than 10, the normal distribution approximation to the binomial expansion was employed in calculating the probability levels. All of the microbiological isolation data were analyzed in this way.

The viral serology analysis results from the blood samples were reported in viral antibody titer. For most of these analyses, six two-fold serial dilutions were performed so seven titer levels were available, beginning at < 10 (no test reaction observed at the lowest dilution level) and increasing by orders of two until the final value, ≥ 320 (test reaction obtained at the highest dilution level). These titer values were recoded for comparison purposes as values from 0 to 6, which each difference of one representing a two-fold change in dilution.

The three poliovirus analyses were conducted using only two dilution levels (10 and 100); this resulted in three titer values (<10, 10 and ≥ 100). For these data, a change from <10 to 10 was considered to be of approximately the same order of magnitude as one from 10 to ≥ 100. Thus the three titers were recoded as 0, 1, 2, and comparisons made of these values. In all cases, the blood samples were paired according to participant and season, and the difference scores were obtained by subtracting the baseline sample titer from the operational sample titer.

Three statistical methods were identified to analyze each set of viral antibody data paired by participant and season to determine whether there was an increase in the operational sampling periods: the paired sample t-test, the Wilcoxon one-sample signed ranks test, and the sign test. The distributions of the antibody difference scores were not normal. Rather, they were leptokurtic, with the frequency of 0 values being much greater than that of surrounding positive and negative integer values. In addition, the titer measurement being the lowest dilution at which a test reaction is observed, does not constitute a continuous variable. Despite these distributional characteristics, the paired sample t-test was considered as a potential statistical method. Snedecor and Cochran(47), (pp. 132-133) suggest that data restricted to a small number of values, thereby involving a substantial number of zeros and ties, might be subjected to an ordinary t-test, with a correction for continuity. However, even with this possible justification for using the more powerful t-test, we decided that the violations of normality and continuity were too severe to warrant its use. (It should be noted that preliminary comparisons showed the t-test results to be quite similar to the Wilcoxon test results; the probability levels for the t-test were slightly lower, but not enough to affect the inferences made.)

Applying the sign test to this non-normal, discontinuous data would result in no invalid assumptions. However, the sign test was rejected because consideration of the observed differences as merely positive or negative would result in too great a loss of sensitivity. Instead, the Wilcoxon one-sample signed ranks test was used, with the inclusion of corrections for continuity and for ties. Following Brownlee's suggestion(45) (p. 260), all pairs yielding zero differences were excluded from the analyses. The resulting sample sizes were large enough (all were greater than 30) to calculate approximate normal deviates for the rank sums. All inferences were based on two-sided tests of significance.

The relationship of pathogen increases to distance was investigated in two ways. The first approach, which was used for the 23 sets of additional serological analyses conducted, was to compare the difference scores for three groups of subjects divided according to the distance and direction they lived from the plant (presumably a measure of exposure). The second method of investigation was stepwise multiple linear regression performed on the organisms which showed evidence of an increase from the baseline to the operational sampling periods.

The results from the 23 additional serological analyses conducted for the 100 participants making up the three exposure groups were reported in viral antibody titer. The statistical methods considered for these multiple group comparisons were the one-way analysis of variance, the Kruskal-Wallis H test, and the chi-square test. Again, the viral antibody difference scores were not distributed normally and did not represent a continuous variable. The parametric one-way analysis of variance was considered inappropriate for these reasons. The non-parametric chi-square test is perhaps the most valid statistical method for this non-normal discrete data because no method assumptions are violated. However, the chi-square test was rejected because it would have caused a loss of sensitivity; in order to get expected frequencies of at least 1.0 in each cell, it would have been necessary to collapse across all positive and all negative differences. This would have caused a loss of all information regarding the magnitude of observed differences, thereby severely reducing the sensitivity of the test.

The statistical method chosen to make the multiple group comparisons was the Kruskal-Wallis H test. This test, a multiple group extension of the Wilcoxon signed ranks test, is a non-parametric version of the one-way analysis of variance. The difference scores were ranked in order of magnitude from negative to positive; the final test statistic was H', which included a correction factor for ties in the data.

The second approach in the investigation of the pathogen-distance relationship involved stepwise multiple linear regression. A regression was performed for each organism exhibiting an overall increase in occurrence or in titer level in the operational sampling periods. This criterion was relaxed, however, in two cases (for the bacteria Streptococcus-alpha and Streptococcus-gamma); these two potential pathogens, while not illustrating an overall increase, did show a significant increase for the nearby Lexington Green participants, along with a decrease or no change for the more distant participants. Since this might be indicative of a more general relationship between distance from the plant and pathogen occurence, these potential pathogens were also regressed. It was also decided that any of the 23 viruses showing titer differences between groups would be subjected to regression procedures to better explicate the plant-virus relationship.

The dependent variables regressed were the paired isolation differences (with values of +1 for + Codes, 0 for 0 codes, and —1 for — codes) or the paired antibody titer difference scores for each selected organism. The paired differences over all analyzed participants in both seasons constituted the number of dependent variable observations. The participant questionnaire data (see Section 5), the distance and direction of each participant residence from the sewage treatment plant, and the season were assembled as the independent observation items to comprise the observation data base. Regressor (independent) variables (candidates to enter the regression equation) were constructed from the independent observation items as various hypothetical explanations for the observed operational period increase in the dependent variable.

The same 34 regressor variables (candidates for the equation) were used in each regression. They are listed in Table 104. Some of the variables came directly from the participant data; others were generated through transformations in the regression program. The regressor variables were constructed to fall into three general categories: possible plant exposure factors, other environmental factors, and personal factors. The exposure group included distance from the plant, hours spent at home each day, type of air-conditioning, direction from the plant, and exposure, which was computed as hours at home divided by distance. These variables, if they entered into the regression equation with the appropriate coefficients, could implicate the plant as a health hazard. As Table 104 indicates, if the sewage treatment plant were the source of the pathogen, one would expect the coefficients to be negative for distance and air-conditioning and positive for hours home and exposure (if these variables had sufficient explanatory potential to enter the regression equa-

TABLE 104. POTENTIAL VARIABLES FOR REGRESSION EQUATION

Possible Plant Exposure Factors	Hypothetical Relationship to Pathogens*	Other Environmental Factors†	Personal Factors†
Distance	–	Season:	Age‡ (9 levels):
		Fall	0-3 yr
Hours Home	+	Winter	4-6 yr
			7-12 yr
Exposure	+	Traffic Proximity	13-18 yr
			19-25 yr
Air Conditioning	–		26-35 yr
			36-45 yr
			46-55 yr
Direction‡ (7 levels):			56 yr and Older
North	+		
East			Smoking Status:
Southeast			Current Smoker
South	+		Former Smoker
Southwest	–		Nonsmoker
West	–		
Northwest	–		Illnesses‡ (4 levels):
			Asthma
			Bronchitis
			Heart Disease
			Arthritis
			Education‡ (5 levels):
			High School Incomplete
			High School Graduate
			College Incomplete
			College Graduate
			Graduate School
			Sex

*If the regression coefficient were to have the indicated sign, it would be consistent with the hypothesis that the pathogen emanates from the sewage treatment plant.

†Factors suggesting causes other than the sewage treatment plant for the operational period increase.

‡The levels applicable to an individual were set equal to 1 for his observation; the other levels were set equal to 0.

tion). The expected direction relationships varied, and were determined from the prevailing wind directions given in Figure 12 for the period of Egan plant operation.

The other two groups of variables, which had no expected relationship to the sewage treatment plant, were included as indications of non-plant factors which might be responsible for the observed pattern of pathogen increases in the operational period. The other environmental factors included season (February vs. October) and traffic exposure (a weighted combination of the distances from the closest freeway and highway). The personal characteristics included sex, age (with nine levels), education (with five levels), smoking status, and prior chronic illnesses (with four levels).

The regression equations were generated in a stepwise fashion according to the usual optimizing algorithm; the "best" equations were chosen through evaluation of ψ (psi), which is equal to the $\log_{10}$ transformed probability level of the F-ratio for each equation. All of the dependent variables, and most of the regressor variables had only two or three possible values for a participant/season observation (for example, the —, 0, + coded paired comparison results from the pathogen isolations were evaluated as —1, 0, + 1; and regressor variables were constructed for each level of the multi-level factors with values of 1/in group and

0/not in group). Thus, strong predictive equations were not expected from the regressions. Rather, the equations were intended merely to assist in interpreting the patterns of pathogen increases that had been observed in the paired data. That is, to determine whether the patterns were associated with the various plant exposure, environmental, and personal characteristics. Also, even though the proportion of variance accounted for by the equations (R^2) was not expected to be large, most equations had enough degress of freedom (about 400), that even relatively small F-ratios were quite significant.

Bacterial Isolations

Pathogenic and potentially-pathogenic bacterial isolates were sought from the feces and sputum specimens and from the throat swabs. The sputum specimens were only analyzed for Mycobacterium tuberculosis; no positive isolates were obtained. The feces specimens and throat swabs were both analyzed for each of the following pathogens and potential pathogens:

Proteus
Pseudomonas
Salmonella
Shigella
Staphylococcus aureus
Staphylococcus epidermidis
Streptococcus-alpha
Streptococcus-beta
Streptococcus-gamma

Proteus, Pseudomonas, and Salmonella were the only pathogen isolates in the feces samples; fecal Streptococci were frequently isolated but are considered non-pathogenic. Staphylococcus aureus and the three Streptococcus groups were the listed pathogens that were frequently isolated from the throat swabs. One isolate each of Proteus and Pseudomonas was also found in the throat swabs.

All of the individual data is tabulated by participant and sampling period in Appendix H. Table A-9 of this appendix contains the bacterial isolation results for Proteus, Pseudomonas, Salmonella, and Enterobacter in each of the feces specimens. The bacterial isolation results for Streptococcus-alpha, Streptococcus-beta, Streptococcus-gamma, and Staphylococcus aureus are presented in Table A-10 of Appendix H. A summary of the isolation data for the frequently isolated pathogens and potential pathogens is given in Table 105 for each sampling period. The preponderance of the feces samples were negative for Proteus, Pseudomonas, and Salmonella. The alpha and gamma types of Streptococci were commonly found in the throat swabs. Isdolation of Staphylococcus aureus and Streptococcus-beta in the throat swabs occurred less frequently.

In addition to the three pathogenic bacteria summarized in the table, isolates of three non-pathogenic bacteria—E. coli, fecal Streptococci, and Enterobacter—were also reported for the feces samples. These bacteria were detected with much greater overall frequency than the pathogens; E. coli was detected in 93% of the samples, fecal Streptococci in approximately 90% to 95% of the samples, and Enterobacter in about 45% of the samples. No consistent patterns of change in incidence were observed in these non-pathogenic bacteria between the baseline and operational periods.

TABLE 105. SUMMARY OF POSITIVE BACTERIAL ISOLATIONS IN FECES SAMPLES AND THROAT SWABS

Period	Samples Analyzed	Positive Isolations	Isolation Percentage
	Feces Samples		
	Proteus		
1	212	26	12
2	205	31	15
3	45	5	11
4	182	8	4
5	190	23	12
	Pseudomonas		
1	214	10	5
2	211	10	5
3	46	1	2
4	206	2	1
5	209	7	3
	Salmonella		
1	208	0	0
2	200	0	0
3	44	1	2
4	210	0	0
5	205	5	3
	Throat Swabs		
	Staphylococcus aureus		
1	223	20	9
2	223	36	16
3	47	2	4
4	202	24	12
5	220	66	30
	Streptococcus-alpha		
1	223	186	83
2	223	183	82
3	47	35	74
4	205	116	57
5	225	175	78
	Streptococcus-beta		
1	223	30	13
2	223	30	13
3	47	3	6
4	202	32	16
5	225	44	20
	Streptococcus-gamma		
1	223	63	28
2	223	135	61
3	47	17	36
4	184	95	52
5	220	116	53

The bacterial isolation results from the feces specimens and throat swabs were paired according to participant and season; the results of their comparisons were coded as—(a change from positive to negative), 0 (either both were positive or both were negative) or + (a change from negative to positive). The results have been tabulated in Tables 106 and 107, by season and paired comparison result; the results for the Lexington Green group have been tabulated separately, as samples were obtained from those participants only in the October sampling periods. The two forms of 0 difference are indicated by the corresponding letters in parentheses, N (both samples were negative) and P (both samples were positive).

The Proteus, Pseudomonas, and Salmonella isolation results from the feces samples are summarized in Table 106. Most of the participants' samples were negative for these three pathogens, as the large values in the 0(N) column indicate. Proteus and Pseudomonas show more decreases overall, while Salmonella shows a greater number of increases. There also seems to be a slight tendency for the number of positive results to be greater in the October sampling periods, especially in the operational year.

The results from the analyses of Staphylococcus aureus, and Streptococcus-alpha, -beta, and -gamma performed on the throat swab specimens are presented in Table 107. Inspection of the table indicates that Staphylococcus aureus and Streptococcus-beta were detected much less often than Streptococcus-alpha and -gamma. However, Staphylococcus aureus and Streptococcus-beta show evidence of an overall increase in isolations. For Staphylococcus aureus, this is due to the large number of positive differences (45) in the October sampling; the February comparisons show a greater number of decreases in isolations of this bacteria. The increased isolation of Streptococcus-beta does not show such a differential pattern with season; -beta was detected more frequently in both the February and October operational periods.

The two other types of Streptococcus bacteria (-alpha and -gamma) illustrate a different pattern of isolation results. They were both much more common, particularly the alpha type which was isolated in almost

TABLE 106. COMPARATIVE ANALYSIS OF BACTERIAL ISOLATIONS IN FECES SAMPLES

	Paired Comparison Results				Total Pairs
		0			
	–	(N)	(P)	+	
		Proteus			
Original Participants–February	23	134	2	5	164
Original Participants–October	15	131	5	13	164
Lexington Green Participants–October	1	27	0	2	30
Total Comparisons Result: Significant Decrease, P=0.019	39	292	7	20	358
		Pseudomonas			
Original Participants–February	9	172	0	2	183
Original Participants–October	8	147	0	7	162
Lexington Green Participants–October	1	29	0	0	30
Total Comparisons Result: No Change	18	348	0	9	375
		Salmonella			
Original Participants–February	0	183	0	0	183
Original Participants–October	0	158	0	4	162
Lexington Green Participants–October	1	27	0	2	30
Total Comparisons Result: Approaching Significant Increase, P=0.13	1	368	0	6	375

TABLE 107. COMPARATIVE ANALYSIS OF BACTERIAL ISOLATIONS IN THROAT SWABS

	Paired Comparison Results				Total Pairs
		0			
	–	(N)	(P)	+	
Staphylococcus aureus					
Original Participants–February	22	167	1	7	197
Original Participants–October	6	131	2	45	184
Lexington Green Participants–October	1	25	0	5	31
Total Comparisons Result: Very Significant Increase, P=0.004	29	323	3	57	412
Streptococcus-alpha					
Original Participants–February	56	3	130	8	197
Original Participants–October	20	1	158	4	183
Lexington Green Participants–October	1	0	22	8	31
Total Comparisons Result: Very Significant Decrease, P<0.00001	77	4	310	20	411
Streptococcus-beta					
Original Participants–February	1	184	0	12	197
Original Participants–October	0	159	0	13	172
Lexington Green Participants–October	1	29	1	0	31
Total Comparisons Result: Very Significant Increase, P=0.00001	2	372	1	25	400
Streptococcus-gamma					
Original Participants–February	57	32	80	28	197
Original Participants–October	31	36	50	67	184
Lexington Green Participants–October	3	5	9	14	31
Total Comparisons Result: No Change	91	73	139	109	412

90% of the throat swabs. Streptococcus-alpha shows a much greater number of decreases than increases overall; the number of positive and negative differences are about the same for Streptococcus-gamma. Both bacteria, however, show more increases than decreases for the Lexington Green participants (those living closest to the sewage treatment plant).

As in the Staphylococcus aureus results, the data for these two Streptococcus bacteria evidence different patterns for the two seasons. Streptococous-alpha, normally detected in the throat swabs, was found much less in the February operational period than in the October period.

Streptococcus-gamma illustrates this same pattern, and also shows more positive differences in the October operational period.

Non-pathogenic bacteria in addition to the listed pathogens were also isolated in the throat swabs. Micrococcus was detected in approximately 60% of the samples; Bacillus and Diptheroid were detected in less than 3% of the samples.

All of the pathogen isolation data sets were statistically analyzed with the sign test. In every case but one (Salmonella isolations in feces samples), the sample sizes were large enough to permit use of the normal curve approximation in calculating the probability of obtaining the observed number of increases or decreases. The inferences made on the basis of these tests (using two-sided levels of significance) were summarized in Tables 106 and 107.

Of the three bacteria analyzed in the feces samples, only Salmonella showed any evidence of increased isolation in operational period samples. This increase only approached significance ($P = .13$), so it cannot be interpreted as very strong evidence of the plant as a source of Salmonella. Proteus and Pseudomonas both showed decreased isolation in the operational periods; the decrease in Proteus isolations was significant ($P = .019$).

The sign tests conducted on the throat swab pathogen isolations revealed very significant increases for Staphylococcus aureus and Streptococcus-beta isolations in the operational periods ($P = .004$ and $P = .00001$, respectively). Streptococcus-alpha isolations, however, decreased very significantly in the operational periods ($P < .00001$).

The bacteria showing significantly increased isolation in the operational periods (Staphylococcus-aureus and Streptococcus-beta) were used as dependent variables in multiple regression procedures. Streptococcus-alpha and -gamma were also regressed, because they showed increased isolation in the participants living closest to the plant (Lexington Green), along with no change or decreased isolation for the more distance participants. A summary of the results of these regressions is presented in Table 108. The regressor factors have been categorized into three general groups: exposure factors, other environmental factors, and personal factors. Each exposure factor has been characterized as to whether it implicates the sewage treatment plant; these characterizations have been made on the basis of the relationship expected between each exposure factor and the pathogen isolations if the plant is indeed serving as a source of aerosolized bacteria and viruses. (The expected direction of the relationship of each exposure variable to the pathogens was presented earlier in Table 104). Finally, the implications of the individual exposure variables were weighed against each other to determine the implications of the entire equation.

The regression equation generated for Staphylococcus aureus accounted for 15.2% of the variance in the dependent variable; the F-ratio for the equation was very significant ($P << .0001$). As Table 108 shows, five regressor variables were included in the equation: southeast direction, season, two levels of age (4-6 years and 7-12 years) and asthma. Inspection of the student t-values for each factor indicates that the direction variable demonstrates a much stronger relationship than any of the other factors; there was a strong tendency for the operational period increases in Staphylococcus aureus to occur in participants living southeast of the plant. The prevailing winds are not from the northwest, however, suggesting that this residential pattern is probably unrelated to the sewage treatment plant. None of the other variables in the equation bear any relation to the sewage treatment plant, leading to a general lack of evidence concerning the plant as a health hazard for this bacterium.

The best equation (according to the C_p statistic) generated for Streptococcus-beta had a multiple coefficient of determination (R^2) equal to .067; even though this indicates that the equation only accounts for a small percentage of variance (about 7%), the F-ratio was still significant ($P = .0004$). Four exposure factors came into the equation—distance, hours at home, air conditioning and southwest direction—but three of the relationships exhibited were in the opposite direction of the expected relationships (see Table 104). That is, pathogen isolation increased as distance from the plant increased, decreased as hours at home increased, and increased in homes with more efficient air oonditioning systems. These reversals of the expected relationships provided negative evidence for the hypothesized plant exposure function of Streptococcus-beta. The fourth exposure factor (southwest direction) showed the predicted relationship—there were fewer increases in isolations for persons living southwest of the plant. Although this was expected (the wind seldom blows from the northeast), it is only indirect evidence; in addition, the low t-value associated with this factor indicates that

TABLE 108. SUMMARY AND INTERPRETATION OF REGRESSION EQUATIONS FOR BACTERIAL ISOLATIONS

Regression Equation		Regressor Variables in Equation				Evidence of Plant as a Potential Health Hazard	
Pathogen Regressed	R^2	Possible Plant Exposure Factors	Other Environmental Factors	Personal Factors	Student t-Value	Exposure Factors	Overall Equation
Staphylococcus aureus	0.152	Direction - increased isolation in southeast direction			6.75		None
			Season - increased isolation in October operational period		2.17		
				Age - decreased isolation in 4-6 yr olds	-2.52		
				Age - increased isolation in 7-12 yr olds	2.73		
				Asthma - decreased isolation in asthmatics	-1.95		
Streptococcus-beta	0.067	Distance - increased isolation with distance			3.80		Very Slight
		Hours home-decreased isolation with hours at home			-1.70		
		Air conditioning - increased isolation in air-conditioned homes			2.54	-	
		Direction - decreased isolation in southwest direction			-1.94	+	
				Age - increased isolation in 36-45 yr olds	2.11		
				Smoking - decreased isolation in ex-smokers	-1.64		
				Illnesses - decreased isolation in persons with arthritis and other diseases	-1.43		
				Education - decreased isolation in households with high school incomplete	-1.42		
Streptococcus-alpha	0.157	Exposure - increased isolation with exposure			3.65	+	Some
		Direction - decreased isolation in west direction			3.92	+	
			Season - decreased isolation in February operational period		3.62		
				Age - increased isolation in 26-35 yr olds	1.98		
				Smoking - increased isolation in current smokers	2.47		
				Illnesses - decreased isolation in asthmatics	-2.02		
				Education - increased isolation in households with high school incomplete	1.66		
				Education - decreased isolation in households with graduate school education	-2.20		
Streptococcus-gamma	0.144	Distance - increased isolation with distance			1.61	-	Slight
		Exposure - increased isolation with exposure			2.21	+	
		Air-conditioning - increased isolation in air-conditioned homes			2.02	-	
		Direction - decreased isolation in west direction			-2.39	+	
		Direction - decreased isolation in northwest direction			-2.68	+	
			Season - increased isolation in October operational period		5.19		
				Age - decreased isolation in 7-12 yr olds	-2.51		
				Age - decreased isolation in 26-35 yr olds	-1.53		
				Age - decreased isolation in 36-45 yr olds	-2.14		
				Age - decreased isolation in those 55 yr and older	-2.42		
				Smoker - increased isolation in current smokers	1.91		
				Illnesses - increased isolation in persons with bronchitis	2.02		
				Education - increased isolation in households with high school incomplete	2.03		

the relationship is fairly weak. The various other personal factors in the equation contribute no evidence concerning the plant, so the entire set of relationships implicates the plant only minimally, if at all.

The regression equation for Streptococcus-alpha included eight regressor variables, had a coefficient of multiple determination equal to .157, and had a significant F-ratio ($P << .0001$). Two plant exposure variables were used in the equation; both illustrated the expected relationships to the increases in isolations. Isolations increased with the computed exposure variable (hours at home/distance) and decreased west of the plant. Inspection of the corresponding t-values indicates that these relationships are fairly strong. However, season also exhibits a strong relationship to isolations. Because an overall decrease in isolations occurred in the operational periods, the seasonal effect is interpreted to mean that more decreases occurred in the February operational period than in the October period.

Two of the most important variables in the Streptococcus-alpha regression are exposure and season. Because the Lexington Green participants were sampled only in the October periods and contained an operational period increase, the exposure and season variables may simply be pointing to a "Lexington Green participant" factor that represents something other than exposure or season. To examine this possibility, a second regression was run, with the Lexington Green participant data excluded. The resulting regression equation did not include exposure. Thus, the original participant isolations give no evidence of plant exposure; it is only in comparing the increased isolations of Lexington Green participants with the decreased isolations of the original participants that an exposure factor appears. However, the west direction, season, and most of the personal factors remained in the equation, suggesting that these represented more general patterns over all participants. In general, the equations provided some evidence for Streptococcus-alpha being related to the treatment plant, although the effect is only evident on the participants living within 0.7 km of the plant.

The regression equation on Streptococcus-gamma accounted for 14.4% of the variance and was significant beyond the .001 level ($P << .0001$). A number of plant exposure variables came into the equation. Three of these variables—exposure, west and northwest—were in the predicted direction; isolations increased with exposure, and decreased for areas west and northwest of the plant. The two other exposure factors—distance and air conditioning—did not exhibit the predicted relationships; the frequency of isolations in the operational period increased slightly with distance, and for homes with efficient air conditioning systems. In addition, as in the Streptococcus-alpha regression, there was a very strong seasonal effect (isolations increased in the October operational period), which may have resulted from including the Lexington Green participants. A second regression in which the Lexington Green participants were omitted did not bring in either distance or the computed exposure variable as equation variables. Rather, it included hours at home; isolations increased with number of hours spent at home during the day. The other regressor variables retained essentially the same relationships as those of the first equation, with season still showing by far the strongest effect. Overall, the Streptococcus-gamma regressions provided slight evidence for the predicted plant-exposure relationship.

In summary, then, the regressions of the two throat swab bacteria showing an overall increase in operational year isolations (Staphylococcus aureus and Streptococcus-beta) demonstrated no, or very little, evidence of a plant-exposure pattern. The regressions of the other two throat swab bacteria did exhibit some plant exposure effects, with the evidence for plant exposure linked to the Lexington Green participants.

Alpha- and gamma-hemolytic Streptococcus species are part of man's normal flora in the intestinal tract, upper respiratory tract and skin, and of his environment (e.g., vegetation, insects, and animal feces) and do not normally produce disease. Therefore, their presence in the vicinity of the wastewater treatment plant or in the throat swabs is of little practical health concern.

Parasite Isolations

Seven hundred eighty-nine feces specimens were analyzed for a variety of helminths (parasitic worms) and protozoa. The following parasites and commensals were sought:

Helminth-Nematodes
- Ascaris lumbricoides
- Enterobius vermicularis
- Hookworm
- Strongyloides stercoralis
- Trichostrongylus sp.
- Trichuris trichura

Helminth-Cestodes
- Diphyllobothrium latum
- Hymenolepis nana
- Taenia sp.

Protozoa
- Chilomastix mesnili
- Dientamoeba fragilis
- Entamoeba coli
- Entamoeba hartmanni
- Entamoeba histolytica
- Endolimax nana
- Giardia lamblia
- Iodamoeba butschlii
- Trichomonas sp.

Protozoa were found in eleven samples; none contained helminths. The protozoans identified and their frequencies are Chilomastix mesnili (1), Entamoeba coli (4), Entamoeba hartmanni (1), Endolimax nana (1), Giardia lamblia (3), and Trichomonas (1).

The parasite results for each feces sample is given in Table A-11 in Appendix H. These parasite data are summarized by sampling period in Table 109. Only 0 to 2% of the participant samples contained parasites.

TABLE 109. SUMMARY OF POSITIVE PARASITE ISOLATIONS IN FECES SAMPLES

	Samples Analyzed	Positive Isolations	Isolation Percentage
	All Parasites*		
Period 1	195	2	1
Period 2	190	1	1
Period 3	45	0	0
Period 4	198	4	2
Period 5	169	4	2

*Organisms isolated: Chilomastix mesnili, Endolimax nana, Entamoeba coli, Giardia lamblia and Trichomonas.

The paired comparison results for the parasite isolations in the feces samples were obtained and coded in the same manner as the bacterial isolation comparisons discussed earlier. These results are summarized in Table 110 according to the season in which the samples were taken; again, the Lexington Green participants have been listed separately, as they were not part of the original participant group.

TABLE 110. COMPARATIVE ANALYSIS OF PARASITE ISOLATIONS IN FECES SAMPLES

	Results of Paired Comparisons				Total Pairs
	−	0		+	
		(N)	(P)		
Parasites					
Original Participants – February	0	155	1	2	158
Original Participants – October	0	121	1	3	125
Lexington Green Participants – October	0	29	0	0	29
Total Comparisons	0	305	2	5	312
Result: Borderline Significant Increase, P = 0.06					

*Organisms isolated: Chilomastix mesnili, Endolimax nana, Entamoeba coli, Giardia lamblia and Trichomonas.

Out of a total of 312 samples pairs, only nine individual samples gave positive results in the isolation analyses. Five of these represented a positive difference between baseline and operational samples. There were no negative differences. These results were evaluated through a sign test; they reached a borderline significance level, using two-sided probability levels (P = .06). However, caution should be exercised in interpreting the relationship of the parasite isolations to the treatment plant. There were improvements in sample collection procedures in Period 5, when three of the five isolation increases (+) occurred; these improved procedures may be responsible for the increase. Also, all five sample pairs showing an increase were obtained from participants living upstream from the plant. Since parasites are generally obtained by swimming or washing clothes in water contaminated with feces, the upstream residence makes it unlikely the Egan plant effluent was the source of the parasites. Thus, the observed borderline significant increase in parasite isolations may be unrelated to the sewage treatment plant.

Viral Isolations

The feces samples and the throat swabs were both analyzed for a spectrum of virus groups and associated microorganisms:

- Adenovirus
- Arbovirus
- Arenavirus
- Coronavirus
- Herpesvirus
- Oncornavirus
- Orthymyxovirus
- Paramyxovirus
- Papovavirus
- Picodnavirus
- Picornavirus
- Poxvirus
- Reovirus
- Rhabdovirus
- Other viruses,
- Chlamydia and Ricksettsia

No viruses were found in the throat swabs. All 20 of the positive virus isolates in the feces samples were Picornaviruses. The Picornavirus group includes Polioviruses, Coxsackieviruses, and Echoviruses (besides the nasal mucosal Rhinoviruses).

The Picornavirus isolation results are tabulated for all participants in A-12 in Appendix H, and summarized by sampling period in Table 111.

TABLE 111. SUMMARY OF POSITIVE VIRAL ISOLATIONS IN FECES SAMPLES

	Samples Analyzed	Positive Isolations	Isolation Percentage
	Picornaviruses		
Period 1	207	0	0
Period 2	199	4	2
Period 3	44	0	0
Period 4	194	9	5
Period 5	183	7	4

The Picornavirus isolation data for the feces samples were compiled in the same manner as the bacteria and parasite isolation data. The results of the paired comparisons are presented in Table 112. Most of the samples were negative, although inspection of the table indicates that the number of positive samples increased in the operational periods.

TABLE 112. COMPARATIVE ANALYSIS OF VIRAL ISOLATIONS IN FECES SAMPLES

	Results of Paired Comparisons				Total Pairs
	–	0 (N)	0 (P)	+	
Picornavirus					
Original Participants–February	2	176	2	5	185
Original Participants–October	0	145	0	7	152
Lexington Green Participants–October	0	28	0	0	28
Total Comparisons	2	349	2	12	365
Result: Significant Increase, $P = 0.016$					

The Picornavirus isolation comparison results were evaluated through a sign test, using the normal curve approximation to the binomial, as the sample size ($N = 14$) was larger than 10. This evaluation indicated that there had been a significant increase in Picornavirus isolations in the operational sampling periods ($P = .016$, two-sided).

After showing that there was a significant overall increase in occurrence of Picornavirus, it was of interest to determine whether this increase conformed to a plant exposure pattern. This question was investigated through a stepwise multiple linear regression procedure, as had been the throat swab bacterial isolations. The same regressor variables were used: potential plant exposure factors, other environmental factors, and personal characteristics. The resulting regression equation explained very little of the variability in the dependent measure ($R^2 = .0334$). However, it did have a significant overall F-ratio ($P = .031$).

The "best" equation chosen through evaluation of the ψ statistic is presented in Table 113. It contained five regressor variables. Two of these were in the plant exposure category (exposure and northwest direction), one was classified with the environmental factors (season), and two were personal characteristics (26-35 years old and asthma). The two potential exposure factors exhibited relationships opposite in direction to those predicted by an exposure pattern (isolations decreased with exposure and were greater northwest of the plant). This of course provided negative evidence for the plant as a Picornavirus health hazard. The other variables in the equation, although useful in characterizing the individuals for whom the positive changes occurred, were unrelated to a sewage treatment plant effect. Thus, the overall equation provides no indication of a plant exposure-virus isolation relationship,

Viral Antibody Titer

Two sets of viral serology tests were conducted on the blood samples. Eight originally-planned serologic tests were conducted on all the participant blood samples to measure the antibody levels to the following eight viruses by the indicated procedure:

Coysackievirus B-1 by hemagglutination inhibition
Echoviruses 3, 7, 11, and 12 by hemagglutination inhibition
Poliovirus types I, II, and III by serum neutralization

A second set of 23 additional serologic tests was conducted on the October blood samples of 100 participants who were classified according to residential distance and direction from the plant into three groups and matched by age and sex (see Tables 102 and 103). These 23 additional tests were:

Adenoviruses 1, 2, 3, 4 and 5 by serum neutralization
Coxsackieviruses A-7, A-9 and A-16 by serum neutralization
Coxsackieviruses B-3, B-5, and B-6 by hemagglutination inhibition
Echoviruses 4, 8, and 33 by serum neutralization
Echoviruses 6, 13, 19, 21, 25, and 29 by hemagglutination inhibition
Reoviruses 1, 2, and 3 by hemagglutination inhibition.

Each viral serology test determined the concentration range of the viral antibody in a blood sample by a titration procedure. Each test was conducted at a series of dilutions of the blood serum. Most tests used six serial two-fold dilution levels: 1 in 10, 1 in 20, 1 in 40, 1 in 80, 1 in 160, and 1 in 320. Whereas most of the viral antibodies tested reflected natural exposure to the virus, many of the poliovirus antibody levels measured presumably resulted from poliovirus vaccinations. Thus, the poliovirus tests were conducted at two ten-fold dilution levels: 1 in 10 and 1 in 100. The serologic test results were reported as a viral antibody titer. The titer is the reciprocal of the greatest serum dilution level which still produces the specified test reaction. For example, an end point dilution of 1 in 40 is reported as a titer of 40. A titer of < 10 indicates that no test reaction occurred at the least dilution (1 in 10). An antibody titer of ≥ 320 for most of the tests or of ≥ 100 for poliovirus indicates that the test reaction occurred at the greatest dilution. Consecutive integer codes were assigned to the geometric series of titer levels to facilitate the data analysis:

Most Viral Antibodies	
Titer	Code
<10	0
10	1
20	2
40	3
80	4
160	5
≥320	6

Poliovirus Antibodies	
Titer	Code
<10	0
10	1
≥100	2

TABLE 113. SUMMARY AND INTERPRETATION OF REGRESSION EQUATIONS FOR VIRAL ISOLATIONS

Regression Equation		Regressor Variable in Equation				Evidence of Plant as a Potential Health Hazard	
Pathogen Regressed	R^2	Possible Plant Exposure Factors	Other Environmental Factors	Personal Factors	Student t-Value	Exposure Factors	Overall Equation
Picornavirus	0.033						None
		Exposure–decreased isolation with exposure			−1.96	–	
		Direction–increased isolation in northwest direction			2.41	–	
			Season–increased isolation in October operational period		1.49		
				Age–increased isolation in 26-35 yr olds	1.43		
				Illnesses–decreased isolation in asthmatics	−1.60		

Thus a code difference of 1 corresponds to a two-fold titer level change for most viruses tested and to a ten- fold titer level change for the polioviruses. The comparison of test results paired by participant and season was made using the difference score of the codes for the paired results. A difference score of 0 indicates both paired results were the same, while a difference score of +2 for most viral antibody tests represents a four- fold increase in titer. Thus, the potential range of difference scores was from —6 to +6 for most of the viral antibody tests and from —2 to +2 for the poliovirus tests.

The individual participant titers on the eight original tests that were conducted on all blood samples in all periods is given in Tables A-13 and A-14 in Appendix H. Table 114 summarizes these antibody titer distributions for the comparable results. The distributions of the Coxsackie B-1 and the four Echoviruses are similar, illustrating fairly wide titer ranges. These distributions are all highly skewed, being dominated by negative (< 10) values. A geometric mean was computed for the titer distribution for each test and period, using the accepted convention of replacing each < value with half the detection limit. Since each titer geometric mean was less than 10, these means were not reported, because values below the detection level cannot be considered numerically meaningful.

The antibody titer for the three polioviruses had different distributional characteristics. The antibody levels to these viruses were very rarely below the detection level, and in fact, values of 100 or greater were by far the most common. For these three viruses, geometric mean antibody levels have been reported for each sampling period and for the total samples. In computing these means, titers < 10 were set equal to 5 and those≥100 were set equal to 100. The means for the Lexington Green participants are noticeably different from those of the original participants.

The baseline and operational means seem to be quite comparable in most cases. One exception occurs in the polioviruses type I antibody titers for the original participants' October samples. These means differ by more than 8 in titer, with the Period 5 mean being greater.

The antibody titer levels for each of the 23 additional tests conducted on both of the October blood samples of 100 selected participants are given in Tables A-15 through A-19 in Appendix H. The summary antibody titer distributions for the three exposure groups are presented for each of these additional tests in Table 115. The antibody titer levels detected by these tests were generally lower than [illegible]r the eight tests conducted on all the participants' sera. However, antibody titer levels of 40 were seen on four of these tests: Coxsackie B-5, Echo 4, Echo 6, and Echo 13.

Table 116 summarizes the difference scores from the paired comparisons of the titers from the eight original tests. As in the previous table, the data have been tabulated by sampling season. The widest range of difference scores was from —4 to +5 for Echovirus 3. Most difference scores were 0, however, indicating the operational period and baseline period titer levels were the same. (Except for the poliovirus tests, the preponderance of sample pairs showing no change came from samples having antibody titers 10 both times.) The result reported with each virus tabulation is from the statistical analysis of the total participant data.

The results of the paired comparisons of the data from the additional tests on the three participant groups are presented in Table 117. The difference scores have been tabulated for each group. The range of difference scores for these tests is typically smaller than for the original tests; the largest difference, which occurs in the Coxsackievirus B-5 comparisons, is +3. Some of the virus groups have particularly low ranges of differences. The Reovirus group, for example, shows only a few +1 differences: Reovirus 2 had no differences at all between the baseline and operational samples. Although the purpose of these tests was to look for differences among exposure groups, not for overall changes, inspection of the table does suggest that the antibody to some viruses demonstrated overall increases in the operational samples (e.g., see Coxsackieviruses A-7, A-9, A-16, Echoviruses 21, 29). However, most of the viruses do not show different patterns of antibody change for the three groups.

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TABLE 114. COMPARATIVE VIRAL ANTIBODY TITER DISTRIBUTION FROM ORIGINAL TESTS ON ALL HUMAN SUBJECTS

	Antibody Titer*	Original Participants February		Original Participants October		Lexington Green Participants		Total Samples
		Period 2	Period 4	Period 1	Period 5	Period 3	Period 5	
Coxsackievirus B-1†								
	<10	157	159	153	150	26	25	670
	10	14	17	8	10	1	1	51
	20	7	2	4	6	1	2	22
	40	3	3	0	0	0	0	6
	80	0	0	1	0	0	0	1
Echovirus 3†								
	<10	125	121	137	131	25	24	563
	10	22	23	24	31	0	1	101
	20	5	9	12	4	1	0	37
	40	4	7	3	2	0	1	20
	80	6	2	2	2	0	0	12
	160	3	3	2	2	0	0	10
	≥320	0	0	1	1	0	0	2
Echovirus 7†								
	<10	146	145	164	159	20	22	656
	10	12	12	12	17	5	3	61
	20	3	5	3	2	1	1	15
	40	1	2	0	2	0	0	5
	80	1	0	1	0	0	1	3
	160	1	0	0	0	1	0	2
Echovirus 11†								
	<10	151	148	164	161	25	24	673
	10	8	10	11	14	1	2	46
	20	2	4	1	2	1	0	10
	40	1	0	2	2	0	1	6
	80	2	1	2	0	0	0	5
	160	1	2	0	1	0	0	4
Echovirus 12†								
	<10	171	172	170	174	26	27	740
	10	14	20	26	23	4	1	88
	20	10	5	2	1	0	1	19
	40	2	1	0	1	0	1	5
	80	0	0	0	0	0	0	0
	160	1	0	1	0	0	0	2
Poliovirus Type I††								
	<10	6	3	4	2	2	2	19
	10	36	38	35	28	10	11	158
	≥100	139	140	127	136	19	18	579
Geometric Mean Titer		57.5	58.9	57.4	65.6	39.3	36.5	57.5
Poliovirus Type II††								
	<10	1	1	2	1	3	3	11
	10	46	45	38	41	8	9	187
	≥100	137	138	126	124	20	19	564
Geometric Mean Titer		55.5	56.2	57.1	55.8	41.4	38.4	54.8
Poliovirus Type III††								
	<10	3	4	4	4	1	1	17
	10	55	54	50	49	7	7	222
	≥100	124	124	112	112	23	23	519
Geometric Mean Titer		47.6	47.4	46.6	47.3	54.1	54.1	47.8

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*Reciprocal of serum dilution.

†Hemagglutination-Inhibition: serum dilution capable of inhibiting four hemagglutinating units of virus.

††Serum Neutralization Test: serum dilution capable of neutralizing 100 $TCID_{50}$ (tissue culture infective doses, 50% effective) virus.

TABLE 115. COMPARATIVE VIRAL ANTIBODY TITER DISTRIBUTION FROM ADDITIONAL TESTS ON 100 HUMAN SUBJECTS

	Antibody Titer*	Group I Lexington Green Participants		Group II Original Participants (near)		Group III Original Participants (far)		Total Samples
		Period 3	Period 5	Period 1	Period 5	Period 1	Period 5	
Adenovirus 1††								
	<10	26	24	39	38	32	31	190
	10	2	4	0	1	1	2	10
Adenovirus 2††								
	<10	25	27	38	37	31	32	190
	10	3	1	1	2	2	1	10
Adenovirus 3††								
	<10	26	25	39	36	32	30	188
	10	2	3	0	3	1	3	12
Adenovirus 4††								
	<10	27	25	39	38	33	30	192
	10	1	3	0	1	0	3	8
Adenovirus 5††								
	<10	28	26	37	36	30	30	187
	10	0	2	2	3	3	3	13
Coxsackievirus A-7††								
	<10	24	22	36	34	29	26	171
	10	4	3	3	5	4	6	25
	20	0	3	0	0	0	1	4
Coxsackievirus A-9††								
	<10	26	22	38	36	33	29	184
	10	2	6	1	3	0	4	16
Coxsackievirus A-16††								
	<10	27	25	38	34	32	31	187
	10	1	3	1	5	1	2	13
Coxsackievirus B-3†								
	<10	24	23	37	34	28	29	175
	10	3	4	2	4	4	3	20
	20	1	1	0	1	1	1	5
Coxsackievirus B-5†								
	<10	24	27	35	32	31	30	179
	10	4	1	3	6	2	2	18
	20	0	0	1	1	0	0	2
	40	0	0	0	0	0	1	1
Coxsackievirus B-6†								
	<10	25	25	38	37	32	30	187
	10	3	3	1	1	1	3	12
	20	0	0	0	1	0	0	1

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*Reciprocal of serum dilution.

†Hemagglutination-Inhibition, serum dilution capable of inhibiting four hemagglutinating units of virus.

††Serum Neutralization Test, serum dilution capable of neutralizing 100 $TCID_{50}$ (tissue culture infective doses, 50% effective) virus.

(continued)

TABLE 115. (continued)

	Antibody Titer*	Group I Lexington Green Participants		Group II Original Participants (near)		Group III Original Participants (far)		Total Samples
		Period 3	Period 5	Period 1	Period 5	Period 1	Period 5	
Echovirus 4††	<10	25	25	33	31	28	27	169
	10	2	3	3	4	3	4	19
	20	1	0	2	3	1	1	8
	40	0	0	1	1	1	1	4
Echovirus 6†	<10	25	26	33	31	29	30	174
	10	3	2	6	7	3	3	24
	20	0	0	0	0	1	0	1
	40	0	0	0	1	0	0	1
Echovirus 8††	<10	26	26	34	37	31	32	186
	10	2	2	5	0	2	1	12
	20	0	0	0	2	0	0	2
Echovirus 13†	<10	25	28	37	34	29	29	182
	10	3	0	2	3	3	3	14
	20	0	0	0	2	1	0	3
	40	0	0	0	0	0	1	1
Echovirus 19†	<10	26	26	35	33	32	31	183
	10	2	2	4	6	1	2	17
Echovirus 21†	<10	27	23	38	33	32	31	184
	10	1	5	1	6	1	2	16
Echovirus 25†	<10	24	23	35	36	33	33	184
	10	4	5	4	3	0	0	16
Echovirus 29†	<10	24	25	38	31	29	29	176
	10	4	3	1	6	4	3	21
	20	0	0	0	2	0	1	3
Echovirus 33††	<10	26	25	35	33	29	31	179
	10	2	3	1	3	3	1	13
	20	0	0	3	3	1	1	8
Reovirus 1†	<10	28	28	39	39	33	31	198
	10	0	0	0	0	0	2	2
Reovirus 2†	<10	28	28	39	39	33	33	200
	10	0	0	0	0	0	0	0
Reovirus 3†	<10	28	28	38	36	33	33	196
	10	0	0	1	3	0	0	4

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*Reciprocal of serum dilution.

†Hemagglutination-Inhibition. serum dilution capable of inhibiting four hemagglutinating units of virus.

††Serum Neutralization Test: serum dilution capable of neutralizing 100 $TCID_{50}$ (tissue culture infective doses, 50% effective) virus.

TABLE 116. SUMMARY OF VIRAL ANTIBODY TITER COMPARISONS FROM ORIGINAL TESTS ON ALL HUMAN SUBJECTS

	Results of Paired Comparisons											Total
	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	Pairs
Coxsackievirus B-1 by Hemagglutination-Inhibition												
Original participants-February	0	0	0	0	14	160	7	0	0	0	0	181
Original participants-October	0	0	0	4	7	142	9	4	0	0	0	166
Lexington Green participants(October)	0	0	0	0	0	27	0	1	0	0	0	28
Total comparisons	0	0	0	4	21	329	16	5	0	0	0	375
Result: No Change												
Echovirus 3 by Hemagglutination-Inhibition												
Original participants-February	0	1	0	0	16	145	16	1	1	0	1	181
Original participants-October	0	1	0	5	18	113	23	4	1	0	0	165
Lexington Green participants(October)	0	0	0	0	1	26	0	0	0	0	0	27
Total comparisons	0	2	0	5	35	284	39	5	2	0	1	373
Result: No Change												
Echovirus 7 by Hemagglutination-Inhibition												
Original participants-February	0	0	0	0	4	169	6	0	1	0	0	180
Original participants-October	0	0	0	2	10	143	7	2	0	0	0	164
Lexington Green participants(October)	0	0	0	0	3	24	0	0	0	0	0	27
Total comparisons	0	0	0	2	17	336	13	2	1	0	0	371
Result: No Change												
Echovirus 11 by Hemagglutination-Inhibition												
Original participants-February	0	0	1	0	7	163	7	2	0	0	0	180
Original participants-October	0	0	1	2	4	146	8	2	1	0	0	164
Lexington Green participants(October)	0	0	0	0	0	25	2	0	0	0	0	27
Total comparisons	0	0	2	2	11	334	17	4	1	0	0	371
Result: No Change												
Echovirus 12 by Hemagglutination-Inhibition												
Original participants-February	0	0	0	1	14	176	8	0	0	0	0	199
Original participants-October	0	0	0	5	16	165	10	2	0	0	0	198
Lexington Green participants(October)	0	0	0	0	2	26	2	0	0	0	0	30
Total comparisons	0	0	0	6	32	367	20	2	0	0	0	427
Result: Significant Decrease, P = .045												

(continued)

TABLE 116. (continued)

		Results of Paired Comparisons				
	-2	-1	0	+1	+2	Total Pairs
Poliovirus Type I by Serum Neutralization						
Original participants-February	0	2	173	6	0	181
Original participants-October	0	0	155	10	0	165
Lexington Green participants (October)	0	2	28	1	0	31
Total comparisons	0	4	356	17	0	377
Result: Significant Increase, P = .014						
Poliovirus Type II by Serum Neutralization						
Original participants-February	0	1	181	2	0	184
Original participants-October	0	3	160	3	0	166
Lexington Green participants (October)	0	1	30	0	0	31
Total comparisons	0	5	371	5	0	381
Result: No Change						
Poliovirus Type III by Serum Neutralization						
Original participants-February	0	1	180	0	0	181
Original participants-October	0	1	163	2	0	166
Lexington Green participants (October)	0	0	31	0	0	31
Total comparisons	0	2	374	2	0	378
Result: No Change						

TABLE 117. SUMMARY OF VIRAL ANTIBODY TITER COMPARISONS FROM ADDITIONAL TESTS ON 100 HUMAN SUBJECTS

	Results of Paired Comparisons					Total Pairs
Adenovirus 1 by Serum Neutralization	-2	-1	0	+1	+2	
Group I (Lexington Green participants)	0	1	24	3	0	28
Group II (Original participants-near)	0	0	38	1	0	39
Group III (Original participants-far)	0	0	32	1	0	33
Total comparisons Result: No Group Difference	0	1	94	5	0	100
Adenovirus 2 by Serum Neutralization						
Group I (Lexington Green participants)	0	2	26	0	0	28
Group II (Original participants-near)	0	0	38	1	0	39
Group III (Orininal participants-far)	0	1	32	0	0	33
Total comparisons Result: No Group Difference	0	3	96	1	0	100
Adenovirus 3 by Serum Neutralization						
Group I (Lexington Green participants)	0	1	25	2	0	28
Group II (Original participants-near)	0	0	36	3	0	39
Group III (Original participants-far)	0	0	31	2	0	33
Total comparisons Result: No Group Difference	0	1	92	7	0	100
Adenovirus 4 by Serum Neutralization						
Group I (Lexington Green participants)	0	1	24	3	0	28
Group II (Original participants-near)	0	0	38	1	0	39
Group III (Original participants-far)	0	0	30	3	0	33
Total comparisons Result: No Group Difference	0	1	92	7	0	100
Adenovirus 5 by Serum Neutralization						
Group I (Lexington Green participants)	0	0	26	2	0	28
Group II (Original participants-near)	0	0	38	1	0	39
Group III (Original participants-far)	0	1	31	1	0	33
Total comparisons Result: No Group Difference	0	1	95	4	0	100

(continued)

TABLE 117. (continued)

	Results of Paired Comparisons							Total
	-3	-2	-1	0	+1	+2	+3	Pairs
Coxsackievirus A-7 by Serum Neutralization								
Group I (Lexington Green participants)	0	0	1	23	2	2	0	28
Group II (Original participants-near)	0	0	0	36	3	0	0	39
Group III (Original participants-far)	0	0	1	28	3	1	0	33
Total comparisons	0	0	2	87	8	3	0	100
Result: No Group Difference								
Coxsackievirus A-9 Serum Neutralization								
Group I (Lexington Green participants)	0	0	0	23	5	0	0	28
Group II (Original participants-near)	0	0	0	37	2	0	0	39
Group III (Original participants-far)	0	0	0	29	4	0	0	33
Total comparisons	0	0	0	89	11	0	0	100
Result: No Group Difference								
Coxsackievirus A-16 by Serum Neutralization								
Group I (Lexington Green participants)	0	0	0	26	2	0	0	28
Group II (Original participants-near)	0	0	0	35	4	0	0	39
Group III (Original participants-far)	0	0	0	32	1	0	0	33
Total comparisons	0	0	0	93	7	0	0	100
Result: No Group Difference								
Coxsackievirus B-3 by Hemagglutination-Inhibition								
Group I (Lexington Green participants)	0	0	1	25	2	0	0	28
Group II (Original participants-near)	0	0	0	36	2	1	0	39
Group III (Original participants-far)	0	0	3	28	2	0	0	33
Total comparisons	0	0	4	89	6	1	0	100
Result: No Group Difference								
Coxsackievirus B-5 by Hemagglutination-Inhibition								
Group I (Lexington Green participants)	0	0	4	23	1	0	0	28
Group II (Original participants-near)	0	0	3	31	4	1	0	39
Group III (Original participants-far)	0	0	1	30	1	0	1	33
Total comparisons	0	0	8	84	6	1	1	100
Result: No Group Difference								

(continued)

TABLE 117. (continued)

	Results of Paired Comparisons					Total
	-2	-1	0	+1	+2	Pairs
Coxsackievirus B-6 by Hemagglutination-Inhibition						
Group I (Lexington Green participants)	0	2	26	0	0	28
Group II (Original participants-near)	0	0	38	0	1	39
Group III (Original participants-far)	0	0	31	2	0	33
Total comparisons Result: No Group Difference	0	2	95	2	1	100
Echovirus 4 by Serum Neutralization						
Group I (Lexington Green participants)	0	2	25	1	0	28
Group II (Original participants-near)	0	1	35	2	1	39
Group III (Original participants-far)	0	2	29	1	1	33
Total comparisons Result: No Group Difference	0	5	89	4	2	100
Echovirus 6 by Hemagglutination-Inhibition						
Group I (Lexington Green participants)	0	1	27	0	0	28
Group II (Original participants-near)	0	1	35	2	0	39
Group III (Original participants-far)	1	2	29	1	0	33
Total comparisons Result: No Group Difference	1	4	91	3	0	100
Echovirus 7 by Serum Neutralization						
Group I (Lexington Green participants)	0	0	28	0	0	28
Group II (Original participants-near)	0	3	34	2	0	39
Group III (Original participants-far)	0	1	32	0	0	33
Total comparisons Result: No Group Difference	0	4	94	2	0	100
Echovirus 13 by Hemagglutination-Inhibition						
Group I (Lexington Green participants)	0	3	25	0	0	28
Group II (Original participants-near)	0	0	36	1	2	39
Group III (Original participants-far)	0	2	29	1	1	33
Total comparisons Result: Borderline Significant Difference, P = .07	0	5	90	2	3	100

(continued)

TABLE 117. (continued)

	Results of Paired Comparisons					Total
	-2	-1	0	+1	+2	Pairs
Echovirus 19 by Hemagglutination-Inhibition						
Group I (Lexington Green participants)	0	0	28	0	0	28
Group II (Original participants-near)	0	2	33	4	0	39
Group III (Original participants-far)	0	0	32	1	0	33
Total comparisons Result: No Group Difference	0	2	93	5	0	100
Echovirus 21 by Hemagglutination-Inhibition						
Group I (Lexington Green participants)	0	0	24	4	0	28
Group II (Original participants-near)	0	0	34	5	0	39
Group III (Original participants-far)	0	0	31	2	0	33
Total comparisons Result: No Group Difference	0	0	89	11	0	100
Echovirus 25 by Hemagglutination-Inhibition						
Group I (Lexington Green participants)	0	0	27	1	0	28
Group II (Original participants-near)	0	1	38	0	0	39
Group III (Original participants-far)	0	0	33	0	0	33
Total comparisons Result: No Group Difference	0	1	98	1	0	100
Echovirus 29 by Hemagglutination-Inhibition						
Group I (Lexington Green participants)	0	1	27	0	0	28
Group II (Original participants-near)	0	0	32	5	2	39
Group III (Original participants-far)	0	2	29	1	1	33
Total comparisons Results: Significant Group Difference, P = .02	0	3	88	6	3	100
Echovirus 33 by Serum Neutralization						
Group I (Lexington Green participants)	0	0	27	1	0	28
Group II (Original participants-near)	0	1	35	3	1	39
Group III (Original participants-far)	0	2	31	0	0	33
Total comparisons Results: Approaching Significant Difference, P = .18	0	3	93	4	1	100

(continued)

TABLE 117. (continued)

Reovirus 1 by Hemagglutination-Inhibition	Results of Paired Comparisons					Total Pairs
	-2	-1	0	+1	+2	
Group I (Lexington Green participants)	0	0	28	0	0	28
Group II (Original participants-near)	0	0	39	0	0	39
Group III (Original participants-far)	0	0	31	2	0	33
Total comparisons Result: No Group Difference	0	0	98	2	0	100

Reovirus 2 by Hemagglutination-Inhibition	Results of Paired Comparisons					Total Pairs
	-2	-1	0	+1	+2	
Group I (Lexington Green participants)	0	0	28	0	0	28
Group II (Original participants-near)	0	0	39	0	0	39
Group III (Original participants-far)	0	0	33	0	0	33
Total comparisons Result: No Group Difference	0	0	100	0	0	100

Reovirus 3 by Hemagglutination-Inhibition	Results of Paired Comparisons					Total Pairs
	-2	-1	0	+1	+2	
Group I (Lexington Green participants)	0	0	28	0	0	28
Group II (Original participants-near)	0	0	37	2	0	39
Group III (Original participants-far)	0	0	33	0	0	33
Total comparisons Result: No Group Difference	0	0	98	2	0	100

The statistical analysis of the paired comparisons from the original eight tests attempted to determine whether the presence of the antibodies to these viruses in human blood samples had increased in the operational year. Parametric statistics were not appropriate for this data, as the antibody data were not normally or continuously distributed. Thus, the Wilcoxon one-sample signed ranks test was used, with the inclusion of corrections for continuity and for ties. The results of these tests are reported in Table 116 with the corresponding paired comparison results. The antibody to two viruses demonstrated significant changes between baseline and operational samples. One of these was the antibody to Echovirus 12, which significantly decreased in the operational period ($P = .045$); the other was poliovirus type I, which evidenced a significant increase after the sewage treatment plant began operation ($P = .014$).

The poliovirus I difference scores were subjected to multiple linear regression procedures to examine whether the pattern is consistent with plant exposure. The resulting equation, which is summarized in Table 118, has an R^2 equal to .095 and a significant F-ratio ($P << .001$). It provides no evidence of the plant as a health hazard. Two of the three potential plant exposure factors which came into the equation do not possess the expected relationships to the antibody titer changes. That is, titers in the operational samples increased for persons living in homes with air conditioning and increased in areas west of the plant. The second direction variable, southeast, had been considered neutral, so its presence does not serve to implicate the plant either.

The traffic variable showed a fairly strong relationship to the titer increases; seemingly, those individuals living closer to major highways or freeways were exposed more to this type of poliovirus. The three personal factors in the equation indicate that the antibody titers decreased more for persons 4 to 6 years and 26 to 35 years and increased for those suffering from asthma.

The analysis of the 23 additional serology tests required comparison of the antibody changes observed in the three exposure groups. It was reasoned that if the plant aerosols were contributing to the presence of viral antibody in the blood, the effect would be proportional to exposure. Our microbiological aerosol sampling and modeling has indicated that the negative exponential of distance from the Egan plant is good measure of long- term cumulative exposure to its microbiological aerosol. Based only on this distance measure, the Lexington Green participants (Group I) were expected to evidence the greatest increase in viral antibody titer. The possibility that other plant exposure factors might enter in (such as wind direction, air conditioning systems, hours spent at home) was also considered. For example, the fact that the Lexington Green area consists of apartment houses, whereas the original participants were predominantly from residential homes, might affect the distance-exposure relationship. Thus, it was desirable to determine not only whether there was an overall difference among groups, but also to determine what these differences were through the use of planned comparisons. The chosen comparisons were Group I vs. Group III, and Group II vs. Group III.

As before, the titer difference scores for these three participant groups were not normally distributed. Therefore, the parametric one-way analysis of variance was inappropriate. The Kruskal-Wallis H test (a nonparametric test) was employed in its place; this test also includes a correction for ties in the data. The test was applied to each of the 23 sets of data; the resulting H^1 statistic was evaluated on the chi-square distribution with 2 degrees of freedom. As indicated by the result statements in Table 117, only the changes in antibody to Echovirus 29 were significantly different from the three groups ($P = .02$). There was a borderline significant group difference in Echovirus 13 antibody ($P = .07$), and a difference approaching significance for the changes in antibody to Echovirus 33 ($P = .18$).

The planned contrasts previously mentioned were conducted on the Echovirus 29 antibody data. Nemenyi's procedure for making a posteriori paired comparison[48] was employed to contrast Group I with Group III, and Group II with Group III. Neither of these comparisons were significant. It was felt that the Nemenyi procedure's lack of a correction for ties decreased its sensitivity, so a Kruskal-Wallis H^1 statistic (for $K = 2$ groups) was calculated for each of the desired comparisons. This procedure found there to be no difference between Groups I and III, and a borderline significant difference between Groups II and III (P .052). Although no formal comparisons were conducted for the Echovirus 13 or 33 data, inspection of these data in Table 117 indicates that the same basic pattern of group differences is present. In each case, it is the Group II

TABLE 118. SUMMARY AND INTERPRETATION OF REGRESSION EQUATIONS FOR VIRAL ANTIBODY TITERS

Regression Equation		Regressor Variables in Equation				Evidence of Plant As A Potential Health Hazard	
Virus Antibody Regressed	R^2	Possible Plant Exposure Factors	Other Environmental Factors	Personal Factors	Student t-Value	Exposure Factors	Overall Equation
Poliovirus Type I	0.095						None
		Air conditioning-increased titer in air conditioned homes			3.28	-	
		Direction-increased titer in southeast direction			3.31		
		Direction-increased titer in west direction			2.87	-	
			Traffic-increased titer with exposure to traffic		3.21		
				Age-decreased titer in 4-6 yr. olds	-1.83		
				Age-decreased titer in 26-35 yr. olds	-2.64		
				Illnesses-increased titer in asthmatics	1.61		
Echovirus 29	0.338						Very slight
		Direction-decreased titer in southeast direction			-3.15		
		Direction-decreased titer in northwest direction			-5.23	+	
			Traffic-decreased titer with exposure to traffic		-3.20		
				Age-decreased titer in 26-35 yr. olds	-1.56		
				Age-increased titer in 56 yrs. and older	1.70		
				Illnesses-decreased titer in those with arthritis	-2.52		
				Illnesses-increased titer in those with bronchitis	1.72		
				Education-increased titer in households with graduate school education	2.79		

participants (close original participants) who show the greatest increases in antibody level. This suggests that there may be some effect related to plant exposure, in that the closer original participants show more antibody increase than those living further from the plant. However, this exposure effect is not present for the Lexington Green participants, as they evidenced no more antibody level increases than did the distant participants. This pattern may be related to some different life styles or personal characteristics, as previously mentioned.

In an effort to determine what factors were contributing to this pattern of titer increase, the Echovirus 29 data from the 100 participants making up the three groups were regressed. For this particular regression, two of the age levels (7 to 12 and 13 to 18) were made unavailable as potential regressor variables, because none of the participants fell into these categories. In addition, season was not used, as all of these blood samples had been taken in October periods.

The resulting equation, also summarized in Table 118, explained 33.8% of the variance and had an F-ratio significant beyond the .001 level. However, the equation provided no direct evidence of the plant as a source of Echovirus 29. One of the direction variables (northwest) did come into the equation with the expected relationship; titers decreased in the area northwest of the plant. This relationship, while quite strong (t = -5.23), provides only indirect evidence against the plant. The other direction variable, southeast, had no expected relationship to the virus; thus, the decrease in areas southeast of the plant provided no damaging evidence.

As in the poliovirus regression, the traffic variable came into this equation with a fairly strong relationship (t = -3.20) to changes in antibody titer. For this virus, however, antibody titer decreased with traffic exposure. Two age variables came into the equation—titer decreased in 26 to 35 year olds and increased in those 56 or older. Current illnesses also illustrated a relationship to the antibody titer, as the titers increased for those suffering bronchitis and decreased for those with arthritis. Finally, education showed a fairly strong relationship (t = 2.79); antibody to the virus increased more for those having a graduate school education.

In general, then, the serology analyses provided little evidence of the sewage treatment plant as an exposure source of virus. For the one virus exhibiting an overall increase in antibody titer (poliovirus I), there was no evidence at all of the expected plant exposure relationship to the observed titer increases. The Echovirus 29 results give slight evidence of an exposure-related pattern in the original participants, but no effect is observed in the closer participants residing at the Lexington Green Apartments. In addition, medical microbiologists generally agree that at least a factor of four increase in antibody titer is necessary before a seroconversion is said to have taken place indicating an immune response to an infection. In the case of Echovirus 29, only three persons met the minimum requirement for seroconversion, two of which were from Group II and the other from Group III. Considering all of the data, the wastewater treatment plant cannot be implicated with respect to Echovirus 29.

CLINICAL SPECIMEN TRACE METALS

The trace metal concentrations obtained on each individual participant's clinical specimens are presented in the Individual Participant Data Appendix. These data have been grouped by sampling period and by participant age and sex for each trace metal (cadmium, copper, lead, mercury, and zinc) and for each specimen type (blood, feces, hair, and urine). Concentrations for hair are based on dry weight of the sample, while for feces wet weight is used. Blood and urine are based on volume measurements. The summary statistics which have been computed for each metal and specimen period-age-sex subgroup are the geometric mean, the arithmetic mean, and the standard error ($s/\sqrt{n}$). These summary statistics were also computed for the sex, age, and period marginal totals. Summaries of the cadmium concentration in blood, feces, hair, and urine specimens are presented, respectively, in Tables 119, 120, 121, and 122. The lead summary statistics for each specimen type are given in Tables 123 - 126. Tables 127 - 130 contain the mercury summaries, while Tables 131 - 134 present the summaries for copper and zinc. The blood hematocrits summary statistics are also given in this section, in Table 135.

TABLE 119. SUMMARY OF CADMIUM CONCENTRATIONS IN BLOOD

Cadmium Conc. in Blood µg/100 ml	Age	Sampling Period 1				Sampling Period 5			
		No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error	No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error
Human Subjects	Total	171	0.078	0.092	0.004	169	0.095	0.108	0.004
	0-6	11	0.070	0.073	0.007	34	0.083	0.094	0.008
	7-18	52	0.070	0.082	0.007	40	0.089	0.102	0.009
	19-45	79	0.087	0.101	0.007	70	0.102	0.117	0.008
	46+	29	0.074	0.091	0.014	25	0.106	0.116	0.009
Males	Total	87	0.076	0.089	0.006	80	0.100	0.115	0.007
	0-6	7	0.080	0.083	0.008	13	0.090	0.101	0.013
	7-18	31	0.077	0.091	0.011	23	0.088	0.097	0.009
	19-45	35	0.082	0.095	0.009	31	0.108	0.129	0.014
	46+	14	0.062	0.071	0.011	13	0.115	0.128	0.015
Females	Total	84	0.080	0.095	0.007	89	0.091	0.102	0.006
	0-6	4	0.054	0.055	0.006	21	0.079	0.091	0.011
	7-18	21	0.061	0.068	0.007	17	0.089	0.108	0.019
	19-45	44	0.092	0.106	0.009	39	0.097	0.107	0.008
	46+	15	0.087	0.110	0.024	12	0.098	0.102	0.009

TABLE 120. SUMMARY OF CADMIUM CONCENTRATIONS IN FECES

Cadmium Conc. in Feces, μg/g Wet Weight	Age	Sampling Period 1				Sampling Period 5			
		No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error	No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error
Human Subjects	Total	196	0.137	0.158	0.0098	171	0.0906	0.1250	0.0071
	0-6	38	0.154	0.173	0.0131	31	0.1202	0.1585	0.0196
	7-18	51	0.160	0.177	0.0106	43	0.0873	0.1257	0.0148
	19-45	77	0.124	0.146	0.0112	71	0.0873	0.1176	0.0104
	46+	30	0.118	0.134	0.0124	26	0.0763	0.1040	0.0138
Males	Total	95	0.135	0.154	0.0088	84	0.0930	0.1288	0.0110
	0-6	15	0.117	0.128	0.0147	15	0.1343	0.1747	0.0270
	7-18	31	0.154	0.171	0.0136	24	0.1002	0.1409	0.0232
	19-45	35	0.133	0.156	0.0183	32	0.0806	0.1100	0.0167
	46+	14	0.120	0.135	0.0182	13	0.0753	0.0995	0.0194
Females	Total	101	0.140	0.162	0.0085	87	0.0884	0.1213	0.0090
	0-6	23	0.185	0.201	0.0173	16	0.1083	0.1433	0.0286
	7-18	20	0.170	0.185	0.0174	19	0.0733	0.1065	0.0159
	19-45	42	0.118	0.139	0.0131	39	0.0931	0.1238	0.0130
	46+	16	0.116	0.133	0.0174	13	0.0773	0.1085	0.0204

TABLE 121. SUMMARY OF CADMIUM CONCENTRATIONS IN HAIR

Cadmium Conc. in Hair, µg/g Dry Weight	Age	Sampling Period 1				Sampling Period 5			
		No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error	No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error
Human Subjects	Total	229	0.607	1.086	0.086	190	0.431	0.823	0.097
	0-6	49	0.932	1.376	0.217	41	0.824	1.037	0.108
	7-18	59	0.957	1.386	0.188	46	0.550	0.803	0.132
	19-45	89	0.364	0.745	0.098	75	0.273	0.619	0.123
	46+	32	0.564	1.035	0.234	28	0.381	1.086	0.506
Males	Total	108	0.689	1.167	0.144	92	0.571	0.910	0.101
	0-6	22	0.821	1.383	0.430	19	0.725	0.958	0.170
	7-18	34	0.872	1.365	0.294	27	0.635	0.965	0.206
	19-45	37	0.509	0.871	0.143	33	0.486	0.886	0.192
	46+	15	0.656	1.134	0.337	13	0.489	0.784	0.198
Females	Total	121	0.542	1.012	0.099	98	0.332	0.741	0.163
	0-6	27	1.033	1.370	0.191	22	0.921	1.105	0.139
	7-18	25	1.088	1.415	0.203	19	0.449	0.574	0.112
	19-45	52	0.286	0.655	0.134	42	0.174	0.409	0.153
	46+	17	0.494	0.947	0.332	15	0.306	1.349	0.940

TABLE 122. SUMMARY OF CADMIUM CONCENTRATIONS IN URINE

Cadmium Conc. in Urine µg/l	Age	Sampling Period 1				Sampling Period 5			
		No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error	No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error
Human Subjects	Total	225	0.591	0.742	0.039	190	0.488	0.638	0.031
	0-6	45	0.458	0.630	0.107	40	0.405	0.579	0.070
	7-18	58	0.526	0.630	0.052	47	0.316	0.416	0.045
	19-45	90	0.645	0.789	0.062	75	0.589	0.716	0.048
	46+	32	0.812	0.971	0.100	28	0.794	0.885	0.072
Males	Total	106	0.611	0.781	0.062	91	0.502	0.671	0.048
	0-6	20	0.444	0.723	0.231	18	0.396	0.615	0.115
	7-18	34	0.575	0.696	0.079	27	0.340	0.449	0.065
	19-45	37	0.615	0.715	0.072	33	0.664	0.807	0.086
	46+	15	1.056	1.213	0.165	13	0.773	0.868	0.100
Females	Total	119	0.573	0.708	0.048	99	0.475	0.606	0.039
	0-6	25	0.470	0.555	0.059	22	0.413	0.549	0.087
	7-18	24	0.464	0.536	0.055	20	0.286	0.371	0.060
	19-45	53	0.667	0.841	0.092	42	0.537	0.644	0.053
	46+	17	0.644	0.758	0.096	15	0.813	0.900	0.107

TABLE 123. SUMMARY OF LEAD CONCENTRATIONS IN BLOOD

Lead Conc. in Blood ug/100 ml		Sampling Period 1				Sampling Period 2				Sampling Period 5			
	Age	No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error	No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error	No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error
Human Subjects	Total	206	10.30	11.11	0.31	199	10.67	11.42	0.32	171	9.78	10.30	0.26
	0-6	27	10.94	11.47	0.68	26	11.12	11.61	0.68	35	9.53	9.84	0.43
	7-18	57	9.44	9.99	0.46	56	9.76	10.13	0.36	40	9.11	9.39	0.37
	19-45	90	10.20	11.22	0.51	88	10.78	11.86	0.60	70	9.98	10.68	0.46
	46+	32	11.75	12.51	0.83	29	11.85	12.41	0.74	26	10.72	11.29	0.76
Males	Total	101	11.61	12.37	0.44	94	11.88	12.70	0.50	80	10.81	11.35	0.40
	0-6	13	11.07	11.43	0.77	11	11.60	12.25	1.30	13	8.87	9.32	0.84
	7-18	34	9.73	10.35	0.65	33	9.80	10.13	0.46	23	9.84	10.08	0.49
	19-45	39	13.25	13.99	0.75	37	14.07	15.03	0.92	31	12.30	12.82	0.65
	46+	15	12.82	13.55	1.24	13	12.27	12.95	1.22	13	11.45	12.12	1.17
Females	Total	105	9.18	9.90	0.39	105	9.69	10.28	0.38	91	8.96	9.38	0.30
	0-6	14	10.82	11.51	1.13	15	10.78	11.15	0.73	22	9.94	10.15	0.47
	7-18	23	9.04	9.46	0.62	23	9.71	10.13	0.60	17	8.22	8.46	0.49
	19-45	51	8.35	9.09	0.54	51	8.88	9.57	0.61	39	8.45	8.99	0.51
	46+	17	10.88	11.59	1.11	16	11.53	11.97	0.93	13	10.05	10.47	0.98

TABLE 124. SUMMARY OF LEAD CONCENTRATIONS IN FECES

Lead Conc. in Feces, µg/g Wet Weight	Age	Sampling Period 1				Sampling Period 5			
		No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error	No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error
Human Subjects	Total	208	0.956	1.206	0.072	166	0.581	0.723	0.039
	0-6	41	1.169	1.591	0.283	28	0.755	0.891	0.089
	7-18	54	1.102	1.275	0.097	41	0.658	0.784	0.074
	19-45	82	1.084	0.885	0.075	71	0.513	0.669	0.066
	46+	31	0.699	0.901	0.133	26	0.505	0.592	0.068
Males	Total	98	0.958	1.155	0.070	81	0.553	0.695	0.051
	0-6	16	0.900	1.036	0.135	13	0.856	0.985	0.121
	7-18	32	1.236	1.471	0.146	23	0.654	0.797	0.113
	19-45	36	0.927	1.093	0.099	32	0.429	0.546	0.065
	46+	14	0.626	0.729	0.102	13	0.496	0.595	0.109
Females	Total	110	0.954	1.252	0.121	85	0.609	0.749	0.058
	0-6	25	1.384	1.946	0.446	15	0.678	0.809	0.129
	7-18	22	0.933	0.987	0.075	18	0.664	0.769	0.090
	19-45	46	0.854	1.077	0.111	39	0.594	0.771	0.105
	46+	17	0.765	1.043	0.225	13	0.513	0.588	0.188

TABLE 125. SUMMARY OF LEAD CONCENTRATIONS IN HAIR

Lead Conc. in Hair, µg/g Dry Weight	Age	Sampling Period 1				Sampling Period 5			
		No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error	No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error
Human Subjects	Total	228	9.44	17.83	2.54	190	7.36	14.36	2.12
	0-6	49	16.11	22.10	4.60	41	12.32	15.25	1.39
	7-18	58	11.01	16.14	3.57	46	7.75	11.62	2.17
	19-45	89	6.32	14.69	3.73	75	5.06	10.25	1.76
	46+	32	9.60	23.09	11.44	28	8.66	26.17	12.78
Males	Total	107	11.15	17.88	2.90	92	9.75	17.98	4.07
	0-6	22	15.15	24.77	9.77	19	10.77	13.78	1.63
	7-18	33	10.93	18.28	6.17	27	9.90	14.91	3.48
	19-45	37	10.63	15.48	2.49	33	8.66	15.14	3.23
	46+	15	8.34	12.78	2.61	13	11.03	37.72	26.84
Females	Total	121	8.15	17.79	4.05	98	5.65	10.28	1.36
	0-6	27	16.93	19.92	2.77	22	13.84	16.52	2.18
	7-18	25	11.12	13.31	1.64	19	5.47	6.94	1.25
	19-45	52	4.37	14.12	6.16	42	3.32	6.41	1.68
	46+	17	10.86	32.19	21.48	15	7.02	16.17	6.11

TABLE 126. SUMMARY OF LEAD CONCENTRATIONS IN URINE

Lead Conc. in Urine µg/l	Age	Sampling Period 1				Sampling Period 5			
		No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error	No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error
Human Subjects									
	Total	225	8.49	9.97	0.38	190	4.84	6.18	0.30
	0-6	45	9.27	10.53	0.78	40	5.10	6.27	0.68
	7-18	58	8.07	9.14	0.62	47	4.03	5.33	0.51
	19-45	90	8.72	10.63	0.71	75	5.15	6.54	0.47
	46+	32	7.62	8.83	0.77	28	5.17	6.48	0.97
Males									
	Total	106	9.00	10.78	0.87	91	5.07	6.43	0.45
	0-6	20	9.32	11.12	1.48	18	4.37	5.14	0.60
	7-18	34	8.31	9.78	0.95	27	3.74	4.90	0.62
	19-45	37	9.41	11.81	1.29	33	6.48	7.74	0.73
	46+	15	9.19	10.08	1.19	13	6.26	8.02	1.83
Females									
	Total	119	8.06	9.24	0.44	99	4.64	5.95	0.41
	0-6	25	9.23	10.06	0.78	22	5.80	7.19	1.12
	7-18	24	7.75	8.24	0.64	20	4.47	5.91	0.86
	19-45	53	8.26	9.81	0.80	42	4.30	5.60	0.58
	46+	17	6.45	7.72	0.96	15	4.38	5.15	0.80

TABLE 127. SUMMARY OF MERCURY CONCENTRATIONS IN BLOOD

Mercury Conc. in Blood µg/100 ml		Sampling Period 1				Sampling Period 5			
	Age	No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error	No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error
Human Subjects									
	Total	207	0.488	0.752	0.081	169	0.198	0.267	0.016
	0-6	28	0.725	1.499	0.539	34	0.109	0.156	0.019
	7-18	57	0.359	0.578	0.070	40	0.183	0.228	0.025
	19-45	90	0.531	0.696	0.049	70	0.272	0.329	0.023
	46+	32	0.471	0.564	0.057	25	0.208	0.309	0.065
Males									
	Total	102	0.453	0.711	0.114	80	0.187	0.243	0.017
	0-6	14	0.642	1.328	0.773	13	0.135	0.172	0.030
	7-18	34	0.303	0.513	0.084	23	0.176	0.205	0.023
	19-45	39	0.537	0.686	0.077	31	0.232	0.297	0.032
	46+	15	0.524	0.650	0.102	13	0.174	0.250	0.043
Females									
	Total	105	0.525	0.791	0.114	89	0.208	0.289	0.026
	0-6	14	0.819	1.670	0.777	21	0.096	0.146	0.025
	7-18	23	0.461	0.674	0.120	17	0.194	0.259	0.048
	19-45	51	0.527	0.704	0.064	39	0.308	0.354	0.032
	46+	17	0.429	0.489	0.055	12	0.252	0.374	0.127

TABLE 128. SUMMARY OF MERCURY CONCENTRATIONS IN FECES

Mercury Conc. in Feces, g/g Wet Weight	Age	Sampling Period 1 No. of Subjects	Sampling Period 1 Geometric Mean	Sampling Period 1 Arithmetic Mean	Sampling Period 1 Standard Error	Sampling Period 5 No. of Subjects	Sampling Period 5 Geometric Mean	Sampling Period 5 Arithmetic Mean	Sampling Period 5 Standard Error
Human Subjects	Total	207	0.077	0.197	0.050	164	0.066	0.116	0.011
	0-6	41	0.041	0.100	0.037	29	0.031	0.051	0.014
	7-18	55	0.062	0.119	0.022	40	0.056	0.097	0.020
	19-45	80	0.111	0.167	0.017	69	0.100	0.158	0.018
	46+	31	0.097	0.541	0.325	26	0.063	0.110	0.022
Males	Total	98	0.068	0.126	0.017	80	0.058	0.104	0.015
	0-6	16	0.033	0.046	0.011	14	0.031	0.052	0.021
	7-18	32	0.064	0.124	0.033	22	0.063	0.119	0.034
	19-45	36	0.102	0.168	0.031	31	0.080	0.130	0.026
	46+	14	0.061	0.114	0.039	13	0.044	0.072	0.024
Females	Total	109	0.086	0.261	0.094	84	0.075	0.128	0.015
	0-6	25	0.048	0.135	0.060	15	0.031	0.051	0.020
	7-18	23	0.059	0.112	0.027	18	0.049	0.071	0.014
	19-45	44	0.119	0.167	0.019	38	0.121	0.180	0.025
	46+	17	0.143	0.893	0.586	13	0.091	0.147	0.035

TABLE 129. SUMMARY OF MERCURY CONCENTRATIONS IN HAIR

Mercury Conc. in Hair, g/g Dry Weight	Age	Sampling Period 1				Sampling Period 5			
		No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error	No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error
Human Subjects	Total	228	0.638	0.994	0.200	101	0.352	0.457	0.036
	0-6	48	0.809	1.046	0.102	21	0.432	0.513	0.063
	7-18	59	0.631	1.492	0.762	28	0.328	0.395	0.043
	19-45	89	0.562	0.728	0.059	43	0.332	0.468	0.070
	46+	32	0.652	0.739	0.068	9	0.355	0.466	0.105
Males	Total	107	0.547	0.687	0.048	48	0.309	0.392	0.040
	0-6	21	0.710	0.955	0.143	10	0.347	0.431	0.097
	7-18	34	0.463	0.550	0.068	17	0.266	0.333	0.057
	19-45	37	0.511	0.647	0.080	19	0.346	0.431	0.071
	46+	15	0.554	0.720	0.083	2	0.222	0.333	0.248
Females	Total	121	0.732	1.266	0.373	53	0.395	0.516	0.056
	0-6	27	0.895	1.116	0.144	11	0.527	0.587	0.080
	7-18	25	0.960	2.774	1.784	11	0.455	0.491	0.057
	19-45	52	0.602	0.785	0.084	24	0.322	0.498	0.112
	46+	17	0.650	0.757	0.107	7	0.406	0.504	0.123

TABLE 130. SUMMARY OF MERCURY CONCENTRATIONS IN URINE

Mercury Conc. in Urine µg/l	Age	Sampling Period 1				Sampling Period 5			
		No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error	No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error
Human Subjects									
	Total	225	3.70	5.10	0.25	190	1.35	1.81	0.11
	0-6	45	2.78	4.02	0.47	40	1.00	1.24	0.15
	7-18	58	4.77	6.04	0.57	47	1.35	1.73	0.17
	19-45	90	3.92	5.27	0.38	75	1.83	2.39	0.20
	46+	32	2.98	4.42	0.59	28	0.91	1.22	0.23
Males									
	Total	106	3.90	5.24	0.34	91	1.37	1.79	0.15
	0-6	20	3.03	4.32	0.74	18	1.09	1.28	0.16
	7-18	34	4.50	5.45	0.55	27	1.36	1.72	0.22
	19-45	37	4.35	5.82	0.61	33	1.93	2.45	0.31
	46+	15	3.04	4.53	00.92	13	0.08	0.95	0.18
Females									
	Total	119	3.53	4.98	0.36	99	1.33	1.83	0.16
	0-6	25	2.60	3.78	0.60	22	0.93	1.20	0.25
	7-18	24	5.17	6.88	1.11	20	1.35	1.74	0.29
	19-45	53	3.64	4.89	0.49	42	1.76	2.34	0.27
	46+	17	2.92	4.32	0.79	15	1.02	1.45	0.40

TABLE 131. SUMMARY OF COPPER AND ZINC CONCENTRATIONS IN BLOOD

	Age	Copper Conc. in Blood µg/100 ml (Sampling Period 1)				Zinc Conc. in Blood µg/100 ml (Sampling Period 1)			
		No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error	No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error
Human Subjects	Total	207	100.6	103.0	1.51	207	564.9	574.7	7.25
	0-6	28	110.7	112.1	3.57	28	518.5	532.8	23.63
	7-18	57	99.5	101.1	2.28	57	540.9	551.8	14.66
	19-45	90	98.8	101.9	2.62	90	593.1	600.1	9.68
	46+	32	99.2	101.5	3.75	32	573.9	580.5	15.68
Males	Total	102	98.0	99.6	1.67	102	565.5	573.6	9.32
	0-6	14	105.3	106.1	3.47	14	533.8	543.3	28.47
	7-18	34	102.5	104.0	2.82	34	522.4	531.2	16.84
	19-45	39	93.6	94.8	2.34	39	607.6	611.3	10.79
	46+	15	93.2	96.0	5.79	15	593.0	599.8	23.52
Females	Total	105	103.2	106.3	2.47	105	564.3	575.8	11.11
	0-6	14	116.3	118.2	5.93	14	503.6	522.3	38.64
	7-18	23	95.3	96.9	3.71	23	569.5	582.3	25.63
	19-45	51	103.0	107.3	4.12	51	582.2	591.7	14.95
	46+	17	104.8	106.5	4.71	17	557.6	563.5	20.75

TABLE 132. SUMMARY OF COPPER AND ZINC CONCENTRATIONS IN FECES

		Copper Conc. in Feces µg/g Wet Weight (Sampling Period 1)				Zinc Conc. in Feces µg/g Wet Weight (Sampling Period 1)			
	Age	No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error	No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error
Human Subjects	Total	208	15.46	17.17	0.53	208	95.6	108.0	6.5
	0-6	41	14.63	15.89	1.02	41	87.4	116.9	30.3
	7-18	54	17.08	18.51	1.03	54	102.9	111.6	5.9
	19-45	82	15.54	17.50	0.89	82	99.3	106.7	4.6
	46+	31	13.79	15.67	1.40	31	85.6	93.2	6.8
Males									
	Total	98	15.37	17.05	0.80	98	93.0	101.6	4.3
	0-6	16	13.64	15.14	1.93	16	70.8	74.2	6.4
	7-18	32	17.43	19.34	1.54	32	110.2	120.0	8.2
	19-45	36	15.73	17.18	1.26	36	99.2	106.2	6.3
	46+	14	12.47	13.69	1.67	14	73.0	79.0	8.8
Females									
	Total	110	15.54	17.28	0.70	110	98.0	113.6	11.6
	0-6	25	15.31	16.38	1.15	25	99.9	144.2	49.1
	7-18	22	16.59	17.30	1.16	22	93.3	99.3	7.9
	19-45	46	15.39	17.75	1.25	46	99.4	107.1	6.7
	46+	17	14.98	17.31	2.11	17	97.6	104.8	9.3

TABLE 133. SUMMARY OF COPPER AND ZINC CONCENTRATIONS IN HAIR

	Age	Copper Conc. in Hair μg/g Dry Weight (Sampling Period 1) No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error	Zinc Conc. in Hair μg/g Dry Weight (Sampling Period 1) No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error
Human Subjects									
	Total	228	29.0	37.7	2.1	229	170.5	289.7	40.6
	0-6	49	22.1	27.2	3.2	49	129.5	315.6	131.7
	7-18	58	36.7	44.4	3.8	59	163.5	245.3	70.4
	19-45	89	32.5	42.6	3.8	89	189.8	259.9	36.3
	46+	32	21.1	28.0	5.6	32	208.1	414.6	131.4
Males									
	Total	107	25.1	31.7	2.5	108	147.6	223.7	46.5
	0-6	22	19.7	24.9	5.0	22	98.7	120.0	20.6
	7-18	33	32.3	39.3	4.2	34	154.4	276.6	121.1
	19-45	37	26.4	32.8	4.8	37	163.2	187.1	24.1
	46+	15	18.4	22.2	4.3	15	188.1	346.5	182.8
Females									
	Total	121	33.0	43.0	3.2	121	193.9	348.5	64.3
	0-6	27	24.3	29.0	4.1	27	161.6	474.9	235.9
	7-18	25	43.2	51.1	6.8	25	176.9	202.7	27.2
	19-45	52	37.7	49.5	5.3	52	211.3	311.7	59.0
	46+	17	23.9	33.1	9.9	17	227.5	474.7	191.5

TABLE 134. SUMMARY OF COPPER AND ZINC CONCENTRATIONS IN URINE

		Copper Conc. in Urine µg/l (Sampling Period 1)				Zinc Conc. in Urine µg/l (Sampling Period 1)			
	Age	No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error	No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error
Human Subjects	Total	225	10.02	11.14	0.34	225	423	498	33.9
	0-6	45	11.81	13.23	1.05	45	476	627	154.6
	7-18	58	9.69	10.76	0.55	58	452	501	32.3
	19-45	90	10.12	11.19	0.51	90	400	458	24.5
	46+	32	8.22	8.78	0.52	32	372	422	34.7
Males	Total	106	9.89	10.89	0.42	106	429	478	21.6
	0-6	20	11.98	12.97	1.14	20	426	458	40.6
	7-18	34	9.20	10.41	0.72	34	444	498	44.0
	19-45	37	9.73	10.71	0.72	37	445	495	36.3
	46+	15	9.44	9.68	0.59	15	363	418	52.5
Females	Total	119	10.13	11.37	0.53	119	418	516	61.2
	0-6	25	11.67	13.45	1.67	25	520	762	276.0
	7-18	24	10.43	11.26	0.85	24	462	506	47.9
	19-45	53	10.40	11.52	0.71	53	372	432	32.8
	46+	17	7.28	7.99	0.79	17	381	426	47.6

TABLE 135. SUMMARY OF BLOOD HEMATOCRITS

Hematocrits in Blood %	Age	Sampling Period 1				Sampling Period 2				Sampling Period 5			
		No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error	No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error	No. of Subjects	Geometric Mean	Arithmetic Mean	Standard Error
Human Subjects	Total	203	40.4	40.6	0.27	199	41.4	41.5	0.24	168	41.3	41.5	0.29
	0-6	27	37.3	37.3	0.50	26	38.1	38.2	0.37	35	38.1	38.2	0.37
	7-18	56	38.9	39.0	0.38	56	40.0	40.1	0.39	40	40.8	40.9	0.48
	19-45	88	41.7	41.8	0.40	88	42.9	43.0	0.34	68	42.7	42.9	0.47
	46+	32	42.3	42.5	0.63	29	42.7	42.8	0.55	25	43.1	43.2	0.67
Males	Total	98	41.5	41.7	0.42	93	42.6	42.8	0.40	79	43.0	43.2	0.44
	0-6	13	37.4	37.5	0.86	11	38.9	38.9	0.44	13	38.6	38.6	0.42
	7-18	33	39.6	39.7	0.50	32	40.2	40.3	0.60	23	41.4	41.6	0.71
	19-45	37	43.5	43.7	0.64	37	45.5	45.5	0.41	30	45.7	45.8	0.51
	46+	15	44.5	44.6	0.72	13	44.1	44.2	0.86	13	44.6	44.7	0.95
Females	Total	105	39.4	39.5	0.31	106	40.3	40.4	0.24	89	39.9	40.0	0.31
	0-6	14	37.1	37.1	0.61	15	37.6	37.6	0.52	22	37.8	37.9	0.54
	7-18	23	38.0	38.0	0.52	24	39.8	39.9	0.43	17	40.0	40.1	0.52
	19-45	51	40.4	40.5	0.43	51	41.1	41.1	0.30	38	40.5	40.6	0.50
	46+	17	40.5	40.6	0.73	16	41.5	41.6	0.59	12	41.5	41.6	0.[illegible]

Some recurrent age and sex patterns were obtained in comparing the trace metal data for a single period. The adult age groups tended to have higher metal concentrations in their blood specimens than did the child age groups. However, the children generally had higher metal concentrations in their feces and hair specimens. Females tended to have higher metal concentrations in feces than did the males, while the males generally had higher metal levels in their urine.

The changes in metal concentration for a specimen between sampling periods are much more pronounced, however, than are the age and sex patterns. For example, the mean levels of mercury in the blood and urine specimens decreased in Period 5 (October 1976) to less than half of the levels observed in Period I (October 1974). The mean lead levels in the feces and urine samples also decreased substantially in Period 5, to just over half of the Period I levels.

The two-sample t-test was conducted to test the null hypothesis of equal means in periods I and 5 against the two-sided alternative. Prior analyses have shown clinical specimen metal data to be lognormally distributed.(49,50) The relatively large standard errors and the relatively large differences between the corresponding geometric and arithmetic means displayed in Tables 119 - 134 suggest each of these clinical specimen trace metal data sets follow a lognormal distribution rather than a normal distribution. Thus, the two-sample t-tests for differences were performed on natural log transferred data (i.e., assuming a lognormal distribution) for the three trace metals (cadmium, lead, and mercury) in the four clinical specimens (blood, feces, hair, and urine). The hematocrits data appears normally distributed; thus its Period I vs. Period 5 comparison was made on the untransformed data.

The results of these tests for differences in mean metal level between Periods I and 5 are presented in Table 136. The t-statistic has been converted to its probability level P and interpreted with regard to the direction and significance of the detected change. There were significant decreases from Period I (baseline) to Period 5 (operational) for cadmium in feces ($P = .001$) and hair ($P = .02$), for lead in feces ($P << .0001$), and for mercury in blood ($P << .0001$), hair ($P < .0001$); and urine ($P << .0001$). The only significant increase from Period I to Period 5 was for hematocrits.

TABLE 136. CLINICAL SPECIMEN TRACE METAL CONCENTRATION AND HEMATOCRITS PATTERNS

	Significant Change in Geometric Mean from Baseline Period to Operational Period			
	Blood	Feces	Hair	Urine
Trace Metal				
Cadmium:	Possible increase ($P = 0.08$)	Decrease ($P = 0.001$)	Decrease ($P = 0.02$)	Possible decrease ($P = 0.11$)
Lead:	No difference	Large decrease ($P < 0.0001$)	Possible decrease ($P = 0.18$)	Large decrease ($P < 0.0001$)
Mercury:	Large decrease ($P << 0.0001$)	No difference	Large decrease ($P < 0.0001$)	Large decrease ($P << 0.0001$)
Hematocrits	Increase ($P = 0.02$)			

Note: Probability levels P are for a two-sided test.

Since the detected changes in the operational period clinical specimen trace metal concentrations were all decreases, any sewage treatment plant contribution to these levels has obviously been countered and overwhelmed by the factors responsible for the decrease' The identity of these factors is unknown. However, the facts that the different periods samples were stored for differing lengths of time, analyzed at different times, and usually analyzed by different operators, leads to speculation that the differences in levels may be due to analytical factors. In summary, the clinical specimen trace metal data provides no evidence of any adverse sewage treatment plant health effect.

HUMAN SUBJECT CURRENT HEALTH STATUS

The Current Health Status (CHS) Questionnaire completed by each participant during each of his sampling periods was presented in Figure 5 in Section 5. This questionnaire was patterned after the Household Health Survey Questionnaire form, both in the illnesses, diseases, and symptoms investigated, and in the time periods covered. The basis of response and the time period covered for each health category in the CHS questionnaire can be summarized as:

Health Category	Basis of Response	Time Period Covered
Chronic illnesses	Receiving medication	At present
Diseases	Diagnosis	Past year
Symptoms	Experienced	Past three months At present

The dates of the sampling periods and the participant groups (original and/or Lexington Green) providing their current health status were:

Period 1	Oct., 1974	Original participants
Period 2	Feb., 1975	Original participants
Period 3	Oct., 1975	Lexington Green participants
Period 4	Feb., 1976	Original participants
Period 5	Oct., 1976	Original and Lexington Green participants

The Egan plant commenced operations in December, 1975. Subsequently, the participants were instructed in reporting symptoms to substitute Jan. 1—Feb. 20 for "past three months" in Period 4 and the period from March through October for "past three months" in Period 5.

There were 187 of the original participants who completed the Current Health Status questionnaire in all four of the periods they were sampled (Periods 1, 2, 4, and 5). Thirty-two of the participants from the Lexington Green Apartments completed both of their CHS questionnaires (Periods 3 and 5). The positive responses to each chronic illness, disease, and symptom were tabulated for these 187 original participants and 32 Lexington Green participants. The reported incidence of each illness, disease, and symptom has been displayed for the corresponding baseline and operational periods, and accumulated over the relevant baseline-operational comparisons.

The number of participants who were presently receiving medication for each chronic illness is presented in Table 137. Taking medication for asthma-hay fever decreased in incidence, particularly in the Fall. Chronic sinusitis and bronchitis and hypertension had substantial increases in incidence, with the increase in chronic sinusitis and bronchitis occurring in the Fall.

The incidence of disease diagnosis during the previous year is shown in Table 138. The February data on the original participants can not be accumulated with their October data in the total valid comparisons because their one year periods of reporting overlap. The increases reported in the February survey for pneumonia and skin disease may be important, because they may reflect the effect of recent exposure before immunity to a sewage treatment pathogen has developed. A decrease in the reported incidence of anemia occurred in the October surveys.

TABLE 137. CURRENT HEALTH STATUS DATA SUMMARY: INCIDENCE OF "PRESENTLY RECEIVING MEDICATION FOR CHRONIC ILLNESSES"

	Original Participants (October)		Original Participants (February)		Lexington Green Participants		Total Valid Comparisons - All Participants		Substantial Change in Incidence
	Per. 1	Per. 5	Per. 2	Per. 4	Per. 3	Per. 5	Baseline	Operational	
Participants Responding	187	187	187	187	32	32	406	406	
CHRONIC ILLNESSES:									
Tuberculosis	0	0	0	0	0	0	0	0	
Malignancies	0	0	0	0	0	0	0	0	
Asthma-Hay Fever	13	8	3	5	5	2	21	15	-6
Diabetes	1	2	1	2	1	1	3	5	
Heart Conditions	4	1	1	1	1	1	6	3	
Hypertension	2	6	3	5	2	2	7	13	+6
Chronic Sinusitis & Bronchitis	6	11	5	4	0	2	11	17	+6
Arthritis & Rheumatism	4	4	2	7	3	0	9	11	
Rheumatic Heart Disease	1	0	0	0	0	0	1	0	
Thyroid Disease	7	4	7	7	0	0	14	11	
Liver Disease	0	0	0	0	0	0	0	0	
Kidney Disease	1	0	0	0	0	0	1	0	

TABLE 138. CURRENT HEALTH STATUS DATA SUMMARY: INCIDENCE OF "DISEASES DIAGNOSED DURING PAST YEAR"

	Original Participants (October)		Original Participants (February) *		Lexington Green Participants		Total Valid Comparisons*- All Participants		Substantial Change in Incidence
	Per. 1	Per. 5	Per. 2	Per. 4	Per. 3	Per. 5	Baseline	Operational	
Participants Responding	187	187	187	187	32	32	219	219	
DISEASES:									
Polio	0	0	0	0	0	0	0	0	
Infectious Jaundice	0	0	0	0	0	0	0	0	
Pneumonia	5	9	4	9	0	0	5	9	(+5)
Worms	3	0	1	0	0	0	3	0	
Skin Disease	5	7	3	8	0	0	5	7	(+5)
Pleurisy	3	2	1	4	0	0	3	2	
Spinal Meningitis	0	1	0	0	0	0	0	1	
Influenza	21	19	32	31	1	5	22	24	
Croup	4	4	7	3	0	0	4	4	
Sleeping Sickness	0	0	0	1	0	0	0	0	
Anemia	4	1	2	2	3	1	7	2	-5
Dysentery	3	0	2	1	0	0	0	0	
Empyema	0	0	0	0	0	0	0	0	

* The February data may not represent valid comparisons because their time periods overlap the October time periods, and because of the brief period of Egan Plant operation.

The incidence of symptoms reported in each Current Health Status survey is presented in Table 139 for the previous "three month" period. The nominal "three month" period was less than 2 months in Period 4 and more than 7 months in Period 5. Thus, no valid comparisons can be made from Table 139 on the incidence of symptoms experienced during the previous "three months."

The incidence of symptoms being presently experienced during each survey is presented in Table 140. Accumulating incidence over all valid comparisons, there was a decrease in the incidence of diarrhea, but increases in the incidence of severe headache not relieved by aspirin, severe pain in bones and joints with high fever, colicky pains in abdomen, and shortness of breath. There also was an increase in the incidence of sore throats and colds in the February surveys, which may reflect recent exposure to sewage treatment pathogens, before immunity has developed.

A statistical analysis of this Current Health Status data was performed to determine from the self- and seasonally-paired data whether there were any significant changes from the baseline to the operational period in the incidence of any of the reported illnesses, diseases, or symptoms. These paired comparison health data have the same nature as the paired isolations of bacteria, parasites, and viruses in the clinical specimens. Thus, the same statistical procedure was used. Sign tests, with two-sided levels of significance, were used to test the null hypothesis of no difference in incidence of the illnesses, diseases, and symptoms between the valid paired comparisons for the baseline and operational survey periods. Pairs for which occurrence was reported in both the baseline and the operational period were excluded from the analysis. When the number of pairs showing a change was greater than 10, the normal distribution approximation to the binomial expansion was used to calculate the probability level. A change of five in the incidence for the most extreme case (a 0-5 split) yields a two-sided probability level of .062. Thus only illnesses, diseases, and symptoms with at least a difference of 5 in incidence between the baseline and operational periods were considered for analysis by the sign test, since all the other changes would be found insignificant.

All of the illnesses, diseases, and symptoms with a baseline vs. operational change in incidence of at least five over all valid comparisons are indicated in the last column of Tables 137-140. A change of incidence of at least five in the February surveys is also indicated in parentheses in this column. The sign test analysis of these incidence changes is presented in Table 141.

As Table 141 shows, no significant changes were detected in the incidence of any chronic illness, disease, or symptom at the 5% significance level. There were, however, a number of changes having a sufficiently small probability level to possibly reflect a real difference in health status. Those health measures having a possibly significant increase in incidence over both operation periods were hypertension, severe pain in bones and joints with high fever, colicky pains in abdomen, and shortness of breath. Skin disease incidence also showed a possibly significant increase in the February operational period. The decrease in the incidence of anemia and diarrhea was possibly significant.

It should be noted that the incidence of most of the health measures in the Current Health Status survey was so low that only very substantial changes in health status could be detected in our participants. However, there were 18 valid comparison health measures presented in Tables 137-140 that had a combined baseline and operational incidence of ten or more. Even if there were no difference in health status between the baseline and operational periods, one would still have expected one significant change at the 5% significant level just due to random variation. Thus the Current Health Status survey does not, by itself, provide any evidence of a possible sewage treatment plant health hazard.

TABLE 139. CURRENT HEALTH STATUS DATA SUMMARY: INCIDENCE OF "SYMPTOMS EXPERIENCED DURING PAST THREE MONTHS"*

	Original Participants (October)*		Original Participants (February)*		Lexington Green Participants*	
	Per. 1	Per. 5	Per. 2	Per. 4	Per. 3	Per. 5
Participants Responding	187	187	187	187	32	32
SYMPTOMS:						
Severe Headache not Relieved by Aspirin	7	20	16	17	3	6
Severe Dizziness	5	7	3	5	0	1
Severe Pain in Bones and Joints with High Fever	3	3	2	9	1	1
Severe Weight Loss	1	2	0	1	0	0
Severe Night Sweats	2	4	2	5	1	1
Hemorrhagic Rash	0	0	1	2	0	0
Canker Sores Around Mouth	9	13	14	13	5	5
Yellow Eyeballs	0	0	0	0	0	1
Sore Throat	48	83	63	71	8	15
Cough	58	90	94	83	4	16
Cold	69	100	100	94	10	22
Skin Rash: Face	4	7	8	6	1	3
Skin Rash: Arms & Legs	5	13	7	9	0	3
Skin Rash: Body	6	9	5	6	0	3
Diarrhea	34	37	44	31	5	8
Bloody Diarrhea	1	0	1	0	0	0
Bloody Urine	0	0	0	0	0	0
Burning on Urination	1	4	2	1	1	1
Nausea	22	30	31	26	0	9
Vomiting	19	26	31	25	0	5
Yellow Skin	0	0	0	0	0	0
Pain in Chest on Deep Breathing	4	8	5	4	0	3
Weakness of Arms or Legs	4	13	6	8	0	3
Cough up Blood	0	1	0	1	0	0
Stiff Neck with Fever	1	4	3	5	1	0
Stiff Neck with Rash	0	1	1	0	0	0
General Weakness	7	29	14	20	2	8
Draining Ear	2	5	3	1	0	2
Fever Above 103° F	9	11	12	16	1	1
Severe Trouble with Teeth	2	1	3	4	1	1
Colicky Pains in Abdomen	5	10	10	13	1	6
Brown Urine	0	0	0	0	0	0
Shortness of Breath	4	8	4	10	0	1
Convulsions	0	0	0	0	0	0
Unconsciousness (not due to blow on head	0	2	1	0	0	0

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*Because the period "past three months" was reduced to 7 weeks for Period 4 and extended to over 7 months for Period 5, there are no valid comparisons for statistical analysis.

TABLE 140. CURRENT HEALTH STATUS DATA SUMMARY: INCIDENCE OF "SYMPTOMS EXPERIENCING AT PRESENT"

	Original Participants (October)		Original Participants (February)		Lexington Green Participants		Total Valid Comparisons - All Participants		Substantial Change in Incidence
	Per. 1	Per. 5	Per. 2	Per. 4	Per 3	Per. 5	Baseline	Operational	
Participants Responding	187	187	187	187	32	32	406	406	
SYMPTOMS:									
Severe Headache not Relieved by Aspirin	2	2	3	5	0	3	5	10	+5
Severe Dizziness	1	0	2	1	0	1	3	2	
Severe Pain in Bones & Joints with High Fever	0	0	0	5	0	0	0	5	+5
Severe Weight Loss	0	0	0	0	0	0	0	0	
Severe Night Sweats	0	0	2	3	0	0	2	3	
Hemorrhagic Rash	0	0	0	1	0	0	0	1	
Canker Sores Around Mouth	1	2	6	1	0	1	7	4	
Yellow Eyeballs	0	0	0	0	0	0	1	0	
Sore Throat	9	1	7	13	4	2	20	16	(+6)
Cough	18	11	29	32	3	3	50	46	
Cold	17	11	26	33	5	6	48	50	(+7)
Skin Rash: Face	2	1	2	1	0	1	4	3	
Skin Rash: Arms & Legs	2	3	5	4	0	0	7	7	
Skin Rash: Body	3	0	2	2	0	0	5	2	
Diarrhea	5	0	3	2	0	1	8	3	-5
Bloody Diarrhea	0	0	0	0	0	0	0	0	
Bloody Urine	0	0	0	0	0	0	0	0	
Burning on Urination	0	0	1	1	0	1	1	2	
Nausea	1	1	2	1	0	1	3	3	
Vomiting	0	1	0	0	0	0	0	1	
Yellow Skin	0	0	1	0	0	0	1	0	
Pain in Chest on Deep Breathing	1	1	4	0	0	1	5	2	
Weakness of Arms or Legs	0	1	3	4	0	0	3	5	
Cough up Blood	0	0	0	0	0	0	0	0	
Stiff Neck with Fever	0	0	1	1	0	0	1	1	
Stiff Neck with Rash	0	0	0	0	0	0	0	0	
General Weakness	2	1	2	6	0	0	4	7	
Draining Ear	0	0	2	0	0	0	2	0	
Fever above 103°F	0	3	0	1	0	0	0	4	
Severe Trouble with Teeth	2	0	1	1	0	0	3	1	
Colicky Pains in Abdomen	1	3	1	5	0	0	2	8	+6
Brown Urine	0	0	0	0	0	0	0	0	
Shortness of Breath	1	2	1	6	0	0	2	8	+6
Convulsions	0	0	0	0	0	0	0	0	
Unconsciousness (not due to blow on head)	0	0	0	0	0	0	0	0	

* Because the period "past three months" was reduced to 7 weeks for Period 4 and extended to over 7 months for Period 5, there are no valid comparisons for statistical analysis.

TABLE 141. CURRENT HEALTH STATUS STATISTICAL ANALYSIS: SIGN TEST ON INCREASES AND DECREASES IN INCIDENCE

	Paired Incidence Changes		Sign Test Result	
	Baseline Only (-)	Operational Only (+)	Probability Level* P	Interpretation of Significance
CHRONIC ILLNESSES: (presently receiving medication)				
Asthma-Hay Fever	16	10	.33	No Change
Hypertension	2	8	.11	Possible Increase
Chronic Sinusitis and Bronchitis	8	14	.29	No Change
DISEASES: (during past year)				
Pneumonia (February)	4	9	.27	No Change
Skin Disease (February)	2	7	.18	Possible Increase
Anemia	5	0	.06	Possible Decrease
SYMPTOMS: (experiencing at present)				
Severe Headache not Relieved by Aspirin	4	9	.27	No Change
Severe Pain in Bones and Joints with High Fever	0	5	.06	Possible Increase
Sore Throat (February)	5	11	.21	No Change
Cold (February)	19	26	.37	No Change
Diarrhea	7	2	.18	Possible Decrease
Colicky Pains in Abdomen	2	8	.11	Possible Increase
Shortness of Breath	1	7	.07	Possible Increase

SECTION 7

DISCUSSION

This study has examined numerous public health hazards which might possibly be associated with the operation of sewage treatment plants. Many findings relevant to sewage treatment health effects were obtained in Section 6, "Results" from statistical analyses and observations of the study data. These findings are summarized by study area (Results Section) in Table 142. Each finding has also been classified in Table 142 with regard to its health hazard implication for the sewage treatment plant studied. The classification system employed is:

+ +	Strong indication of a potential health hazard
+	Indication of potential health hazard
+ (?)	Uncertain indication of potential health hazard
?	Health implication is uncertain
— (?)	Uncertain indication of no health hazard
—	Indication of no health hazard
— —	Strong indication of no health hazard
(blank)	Irrelevant to health implications

The health importance, statistical significance, and methodological difficulties associated with each finding were considered in obtaining its hazard classification.

The Egan plant was a reasonable study site. The aeration basin contained fairly high levels of many pathogenic bacteria (Pseudomonas, fecal Streptococci, Klebsiella, Mycobacteria, Staphylococcus, and Providencia). However, Salmonella and Shigella, "the most important wastewater-borne enteric pathogenic bacteria encountered in the United States,"[51] were not detected. Coliphage and enteroviruses were found in nearly every sample. The analytical methods used indicate that most of the enteroviruses were polioviruses and that they were found primarily in the solids fraction of the mixed liquor. The first stage aeration basin contained high concentrations of cadmium, lead, and mercury in Period 5.

The air sampling shows that the Egan plant's aeration basins are a localized source of indicator organisms in the air (standard plate count, total coliform, and fecal coliform). The occasional presence of hardy pathogenic microorganisms (Pseudomonas, fecal Streptococci, Klebsiella, and a single enterovirus (typed as poliovirus III) in the downwind samples suggests that the aeration basin is also an aerosol source of these pathogens. Most of the microbiological particles were in the respirable range. The first stage aeration basin also appears to be a source of aerosolized mercury. However, there were no significant differences between any residential upwind and residential downwind levels (≥300 m). The levels of microbiological or chemical agents of the air, water, and soil samples in the residential areas, were not distinguishable from the background levels.

The levels of lead in the soil and of total coliforms and mercury in the water were significantly higher after the sewage treatment plant was in operation, but in each case the increase did not primarily occur in the samples taken close to the sewage treatment plant. No pathogenic bacteria or viruses were isolated in any soil or water sample. Again, no contribution of the sewage treatment plant to microbiological or chemical levels in the soil and water in the plant vicinity could be detected.

TABLE 142. SUMMARY AND CLASSIFICATION OF FINDINGS REGARDING HEALTH IMPLICATIONS OF A SEWAGE TREATMENT FACILITY

Study Area of Results	Findings Relevant to Sewage Treatment Health Effects	Hazard Classification
A. ENVIRONMENTAL MONITORING		
1. Aeration Basin Samples		
a. Microbial characterization		
	• The levels of Klebsiella, Mycobacteria, Staphylococcus, and Providencia were fairly high relative to the microbiological indicator levels.	+ (?)
b. Microbiological data		
	• Salmonella, Shigella, and Proteus (pathogenic bacteria) were not detected.	− −
	• Enteroviruses (presumably poliovirus) were nearly always found, but predominantly in the solids fraction of the sample.	?
	• Pseudomonas, fecal streptococci, and coliphage were consistently found.	+ (?)
	• The first stage aeration basin had much higher coliform levels than did the second stage.	
c. Trace metal data		
	• The first stage aeration basin contained much higher concentrations of cadmium, lead, and mercury in October than did the second stage in February.	
	• There was little daily variation in the levels of the trace metals.	
2. Air Samples		
a. Microbiological data		
	• Klebsiella was occasionally detected in the aerosol downwind of the aeration basin, as far as 300 m.	+ (?)
	• An enterovirus plaque was detected in one aerosol sample, at 300 m downwind from the aeration basin.	+ (?)
	• Coliphage and fecal streptococci were found infrequently in the downwind aerosol.	− (?)

(continued)

TABLE 142. (continued)

Study Area of Results	Findings Relevant to Sewage Treatment Health Effects	Hazard Classification
	• Most microbiological particles in the aerosol emanating from the aeration basin are in the respirable range (primarily 3.3 to 7.0 microns in diameter).	+ (?)
	• The aeration basins are a significant source of total coliforms, fecal coliforms, and standard plate count. However, there is no significant difference between the residential upwind and residential downwind (>300 m) levels of total coliform, fecal coliform, or standard plate count.	– (?)
	• There is no significant difference between the upwind and close downwind levels of Pseudomonas.	– (?)
b. Trace metal data		
	• The first stage aeration basin was a borderline significant source of aerosolized mercury. However, there is no difference in the mercury levels between the residential upwind and residential downwind locations.	– (?)
	• There is no significant difference between the upwind and close downwind levels of cadmium or lead.	–
3. Soil Samples		
a. Microbiological data		
	• No pathogenic bacteria (particularly Streptococcus-beta, Staphylococcus aureus, Salmonella, Shigella, and Klebsiella pneumoniae) were isolated in any soil sample.	–
	• No viruses were isolated via plaques or cytopathogenic effect.	–
	• The standard plate count was significantly lower in the operational periods than in the baseline periods.	–
b. Trace metal data		
	• The lead levels were significantly higher in the operational periods than in the baseline periods, but the increase occurred in the distant samples rather than in the samples taken close to the sewage treatment plant.	– (?)
	• There were no significant differences between the baseline and the operational levels of cadmium, mercury, copper, and zinc.	–

(continued)

TABLE 142. (continued)

Study Area of Results	Findings Relevant to Sewage Treatment Health Effects	Hazard Classification
4. Water Samples		
a. Microbiological data		
	• No pathogenic bacteria (particularly Salmonella, Shigella, and Vibrio) or fecal coliforms were found in any water sample.	–
	• No viruses were isolated via plaques or cytopathogenic effect.	–
	• The MPN total coliform level was significantly higher in the operational periods than in the baseline periods, but the increase was unrelated to distance from the sewage treatment plant.	– (?)
b. Trace metal data		
	• The mercury levels were significantly higher in the operational periods than in the baseline periods, but the increase was unrelated to distance from the sewage treatment plant.	– (?)
	• There was no significant difference between the baseline and the operational levels of lead.	–
B. HOUSEHOLD HEALTH SURVEY		
1. Household and Personal Characteristics		
	• The operational survey households had higher occupational status, fewer bedrooms, and more air conditioning than the baseline households. The two surveys did not differ in racial composition, head of household education, or household size.	
	• The operational survey had a more balanced distance and directional distribution about the sewage treatment plant.	
	• The operational survey households were located closer to expressways, multilane highways, and industrial operations. Their length of residence was longer.	
	• Fewer young children were surveyed in the operational period, both overall and within 2.0 kilometers of the sewage treatment plant. The effect of this age pattern must be taken into account for those health parameters for which a potential health effect is observed, and for which incidence is related to age.	

(continued)

TABLE 142. (continued)

Study Area of Results	Findings Relevant to Sewage Treatment Health Effects	Hazard Classification
2. Analysis of Health Survey Illness, Disease, and Symptom Incidence		
	• There were significant increases in incidence in the operational period close to (within 2 km) the sewage treatment plant (with a significant survey x distance interaction), occurring mainly in the downwind directions, for the symptoms of nausea, vomiting, and general weakness. Influenza displayed the same pattern, but with only a slight increase close to the plant.	+
	• There were patterns of significantly increased incidence close to the sewage treatment plant (without a significant interaction), occurring mainly in the downwind directions, for skin disease and the symptoms of diarrhea and pain in chest on deep breathing.	+
	• There was a pattern of elevated incidence close to the sewage treatment plant (with a significant interaction) for dysentery.	?
	• There were significant decreases in incidence in the operational period survey (with a significant interaction), especially close to the sewage treatment plant, for worms and sore throat.	–
	• There were significant operational survey decreases in incidence (without a significant interaction), also occurring close to the sewage treatment plant, for chronic sinusitis and bronchitis and for fever above 103°F.	–
	• The significantly increased incidence of skin disease, diarrhea, nausea, vomiting, general weakness, and pain in chest on deep breathing, and the elevated incidence of influenza, close downwind from the sewage treatment plant cannot be attributed to age confounding. The increased close-in incidence of these health parameters tended to occur over all age categories. Furthermore, influenza, diarrhea, nausea, and vomiting generally occur more frequently among children, but there were fewer children within 2 kilometers of the sewage treatment plant in the operational survey, so that a decreased close-in incidence would have been anticipated from the surveyed age distribution.	+

(continued)

TABLE 142. (continued)

Study Area of Results	Findings Relevant to Sewage Treatment Health Effects	Hazard Classification
	• All of the diseases and symptoms displaying significantly increased incidence (skin disease, diarrhea, nausea, vomiting, general weakness, and pain in chest on deep breathing) or elevated incidence (influenza) close downwind from the sewage treatment plant during the operational survey are considered, from a medical standpoint, to be likely or possibly related to the presence of a sewage treatment plant.	+
	• All of the health parameters (chronic sinusitis and bronchitis, worms, sore throat, and fever above 103°F) having significantly decreased incidence close to the sewage treatment plant are also considered, from a medical standpoint, to be likely or possibly related to the presence of a sewage treatment plant.	–
C. HUMAN SUBJECT CHARACTERISTICS		
	• Only the additional human subjects recruited from the Lexington Green Apartments lived within 1 km of the sewage treatment plant. These additional subjects differed from the original human subjects by consisting of more females and fewer school age children.	
	• A majority (51%) of the human subjects expected to spend no more than one hour per day more than 2 miles from their homes.	
D. CLINICAL SPECIMEN MICROBIOLOGY		
1. Bacterial Isolations a. Feces samples		
	• There was a significant decrease in Proteus isolations in the operational periods.	–
	• There were no significant differences in the isolations of Pseudomonas or Salmonella between the baseline and operational periods.	–

(continued)

TABLE 142. (continued)

Study Area of Results	Findings Relevant to Sewage Treatment Health Effects	Hazard Classification
b. Throat swabs		
	• There were very significant increases in the isolation of Streptococcus-beta and Staphylococcus aureus in the operational periods. Regression analysis suggests that the increases are unrelated to the level of the participant's sewage treatment plant exposure.	– (?)
	• Isolations of Streptococcus-alpha and Streptococcus-gamma increased significantly for the close-in (400m-600m) Lexington Green subjects in the operational period. Isolations in the operational periods decreased significantly for Streptococcus-alpha and remained unchanged for Streptococcus-gamma for the more distant original subjects. Regression yields some evidence that these isolations may be related to sewage treatment plant exposure.	+ (?)
c. Sputum samples		
	• No Mycobacterium tuberculosis was isolated in any sputum sample.	–
2. Parasite Isolations		
	• There was a nearly significant increase in parasitic incidence in feces in the operational periods. However, improvements in sample collection methods and the upstream location of all five parasitic subjects' residences suggest the increase may be unrelated to the sewage treatment plant.	– (?)
3. Viral Isolations		
a. Feces samples		
	• The only viruses isolated were Picornaviruses, which include polioviruses, Coxsackieviruses, and Echoviruses. There was a significant increase in Picornavirus isolations in the operational periods. The increase does not appear to be related to sewage treatment plant exposure.	– (?)
b. Throat swabs		
	• No viruses were isolated in any of the throat swab samples.	–

(continued)

TABLE 142. (continued)

Study Area of Results	Findings Relevant to Sewage Treatment Health Effects	Hazard Classification
4. Viral Antibody Titers		
a. Tests on all human subjects		
	• There was a significant increase in the poliovirus I titer obtained by serum neutralization, which appears to be unrelated to sewage treatment plant exposure.	– (?)
	• Tests for six types of polio, Coxsackie, and Echo viruses showed no difference in titer between the baseline and operational period samples. There was a significant decrease in Echovirus 12 titer by hemagglutination inhibition.	–
b. Additional tests on 100 human subjects		
	• The Echovirus 29 titer obtained by hemagglutination inhibition increased significantly in the operational period, with the increase showing a slight exposure relationship, but only among the original participants.	+ (?)
	• There were no significant differences in titer level for the other 22 viral antibody tests.	–
E. CLINICAL SPECIMEN TRACE METALS		
	The following clinical specimen trace metal concentration patterns were found for the operational period relative to the baseline period:	
1. Cadmium		
	• Significantly decreased cadmium levels in the feces and in the hair. Possibly decreased urine levels and possibly increased blood levels.	– (?)
2. Lead		
	• Very significantly lower lead levels in the feces and urine. A possible decrease in hair lead levels. No change in blood lead levels.	–

(continued)

TABLE 142. (continued)

Study Area of Results	Findings Relevant to Sewage Treatment Health Effects	Hazard Classification
3. Mercury		
	• Very significantly lower mercury levels in the blood, hair, and urine. No change in the fecal mercury level.	–
4. Hematocrits		
	• A significant increase in the hematocrits percentage of the blood.	
F. HUMAN SUBJECT CURRENT HEALTH STATUS		
	• There were no significant changes from the baseline period to the operational period in the incidence among the human subjects of taking medication for any chronic illness, of diagnosis of any disease, or of experiencing any symptom.	–
	• There was a possibly significant increase in the incidence of hypertension, skin disease in February, severe pain in bones and joints with high fever, colicky pains in abdomen, and shortness of breath.	?
	• There was a possibly significant decrease in the incidence of anemia and diarrhea.	–

The household health survey indicated that increased incidence of skin disease and the symptoms of nausea, vomiting, general weakness, diarrhea, and pain in chest on deep breathing occurred close to the sewage treatment plant and predominantly in the downwind direction after it was in operation. The facts that each of these diseases and symptoms could be caused by pathogens found or presumed to exist in the aeration basin and that their incidence is not attributable to changes in the surveyed age distribution suggest the sewage treatment plant as a possible cause. However, a "normal" sporadic outbreak of these diseases and symptomatology in the schools or communities just north and south of the plant is also a reasonable explanation. Since the survey relied on the respondent's memory of prior diseases and symptoms within the family, its evidence is non-medical and possibly subjective. Also, the possibility that dissatisfaction with the treatment plant stimulated the memory of some nearby residents cannot be dismissed.

The possibility for biased responses from participants was considered during recruitment. All prospective participants were told the objectives of the study. Each was informed that they were to be a part of the study and none were told that they were a part of a group close to the plant or far from the plant. It, therefore, seems improbable that biased responses would be obtained from participants which are related to distance and in some cases direction from the plant.

The incidence with which some bacteria, parasites, and viruses were isolated in the clinical specimens increased in the operation periods. Isolations of beta hemolytic Streptococci and Staphylococcus aureus in the throat swabs increased very significantly. There were significantly increased isolations of Picornaviruses in feces and, for the closest subjects, of alpha and gamma hemolytic Streptococci in their throat swabs. The increase in the incidence of parasitic protozoa in the feces was nearly significant. Regression analysis of the isolation increases with respect to distance, direction, hours home, and air conditioning level indicated that most of these isolation increases appeared unrelated to the subject's anticipated exposure to the sewage treatment plant's aerosol. The exceptions were alpha and gamma hemolytic streptococci in the throat swabs, for which the increase did bear some relation to presumed aerosol exposure, although these are not of practical health significance.

It is surprising that no adenoviruses or reoviruses were isolated in over 800 feces samples, and that no viruses at all were isolated in more than 900 throat swabs. It is not known if there were deficiencies in the methods of collection, shipping, or the holding time prior to analysis. In retrospect, our practice of storing all of the frozen samples from a sampling period and shipping them as a batch to the analytical laboratory was probably unwise. It overburdened the laboratory upon receipt and delayed the sample analysis. However, in sampling Periods 2, 4 and 5, approximately two positive control samples each of feces and throat swabs were seeded with poliovirus in the field, shipped with the regular samples, and analyzed blind; in each case the poliovirus was isolated.

Viral serology detected significant operational period titer increases for poliovirus I and Echovirus 29, with the Echovirus 29 titer increases showing a slight relationship to sewage treatment plant exposure only among the original participants. There was a significant decrease in Echovirus 12 titer and no change in titer for 28 other viral antibodies.

The environmental monitoring did not show that the sewage treatment plant was a source of trace metals for ambient air in the residential area. It is not surprising that levels of these metals in the participants (hair, blood, urine and feces) were not related to the sewage treatment plant. The levels of lead and cadmium seen in the participants are comparable to other studies(46,50) of middle class suburban populations without occupational exposures to these metals. Differences in levels of lead in the air and soil and in participants might be explained by their proximity to a freeway in the study area.

Although not an objective of this study, the trace metal data on more than 200 participants will provide important information regarding levels present in suburban populations in the United States. Air data for each trace metal are available for each participant's neighborhood over a two-year period. Detailed questionnaire information is available for each participant and data for hair, urine, blood and feces for the trace metals are available for the same participants sampled during a two-year span.

If the aeration basin, air, soil, and water sampling were to establish the sewage treatment plant as an aerosol source of a particular pathogen or metal, and if there were corresponding appropriate patterns of its elevated levels in the clinical specimens, and of the increased incidence of its resulting symptoms and diseases, then this corroboration would strongly implicate sewage treatment as a public health hazard. However, the environmental monitoring, clinical specimen, and health survey findings are too isolated to provide corroboration. The symptoms and diseases with possible plant-related patterns have too many potential causes to warrant any association with the pathogens and trace metals found to have an exposure-like pattern.

The experimental design employed in this study was to compare baseline and operational levels during each of two seasons. When significant increases occurred, their occurrence was related to measures of sewage treatment plant exposure such as distance and direction to infer the relationship to exposure. This is a sensitive design for identifying health hazards and inferring whether the sewage treatment plant may be their source. However, the findings obtained in this study, when considered overall, did not detect a public health hazard for persons living beyond 400 meters from a well-operated sewage treatment plant. Greater sensitivity is required before an epidemiology study can be expected to obtain firm evidence regarding the potential health hazard closer than 400 meters from a sewage treatment plant. Methods to achieve greater sensitivity include the recruitment of health survey respondents and human subjects living considerably closer to the sewage treatment plant than in this study, the use of daily health diaries, and improving the collection, shipping, and analytical methodologies in such areas as pathogen isolation.

The most useful sources of health effects information in this study have been microbiological environmental monitoring, the household health survey, and viral serology. These areas should form the basis of future epidemiological investigations of sewage treatment plant health hazards.

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APPENDIX A

JUSTIFICATION OF SURVEY QUESTIONNAIRE FORMS

Clearance requests and justification for each of the three questionnaire forms developed and used in this study are presented in this Appendix. Each justification is preceded by an OMB Form 83, Clearance Request and Notice of Action.

STANDARD FORM NO. 83
OFFICE OF MANAGEMENT
AND BUDGET

CLEARANCE REQUEST AND NOTICE OF ACTION

(Under Federal Reports Act and Bureau of the Budget Circular No. A-40, as amended)

FOR O.M.B. USE

IMPORTANT – Submit the required number of copies of SF-83, together with the material for which approval is requested to:

CLEARANCE OFFICER
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

READ INSTRUCTIONS BEFORE COMPLETING FORM

PART A – REQUEST BY FEDERAL AGENCY FOR CLEARANCE

*Items marked with asterisk may be omitted for preliminary plans or recordkeeping requirements

1. SEND "NOTICE OF ACTION" TO: Name and mailing address

2. Bureau and division or office originating request

3. Name(s), title(s), and telephone numbers of person(s) who can best answer questions regarding request.

FORM OR DOCUMENT IDENTIFICATION

4. Title of form or document submitted
HOUSEHOLD HEALTH SURVEY

***5.** Agency Form Number(s)

6. Type of form or document
1 ☐ Application
2 ☐ Program evaluation
3 ☐ Other management report
4 ☐ Statistical survey or report
5 ☐ Preliminary plan or contract
6 ☐ Recordkeeping requirement
7 ☐ Other – *Specify*

7. Current (or former) O.M.B. clearance – Number
Expiration date

8. Requested expiration date

9. Type of request
1 ☒ New
2 ☐ Revision
3 ☐ Extension (No change)
4 ☐ Reinstatement

***10.** Frequency of use
1 ☐ Single time
2 ☒ On occasion
3 ☐ Weekly
4 ☐ Monthly
5 ☐ Quarterly
6 ☐ Semi-annually
7 ☐ Annually
8 ☐ Other *(See instructions)*

11. Related forms or documents *(Give O.M.B. number. Enclose in parentheses any to be replaced.)*

12. Catalog of Federal Domestic Assistance program number (if applicable)

COLLECTION AND RESPONDENTS

***13a.** Collection method *(Check as many as apply)*
1 ☐ Mail
2 ☒ Personal interview
3 ☐ Other – *Describe*

***13b.** Collected by –
4 ☐ Agency
5 ☐ Contractor
6 ☐ Other – *Describe*

14a. Type of respondents involved *(Check predominant one)*
1 ☒ Individuals or households
2 ☐ Business firms (non-farm)
3 ☐ Farms
4 ☐ Government agencies
5 ☐ Other – *Describe*

14b. Brief description of respondents (i.e., "households in 50 largest SMSA's; "retail grocery stores")

***15.** Summary of estimated respondent burden

	Number
a. Estimated number of respondents	2000
b. If sample, approximate number in universe	over 1 million
c. Reports filed annually by each respondent (item 10)	once
d. Total annual responses (a X c)	2000
e. Estimated average number of man-hours required per response	1/2
f. Estimated TOTAL MAN-HOURS of respondent burden (d X e)	1000

AUTHORITY AND CONFIDENTIALITY

***16a.** Is report form –
1 ☒ Voluntary?
2 ☐ Required to obtain benefit?
3 ☐ Mandatory? *Cite statute*

***16b.** Does your agency pledge confidentiality?
1 ☒ Yes 2 ☐ No

CONSULTATIONS OUTSIDE AGENCY

17. In developing the report form or other documents, were consultations held with individuals or organizations outside your agency?
1 ☒ Yes – If "yes," identify persons and describe outcome in SUPPORTING STATEMENT. *(See instructions)*
2 ☐ No

CERTIFICATION BY AUTHORIZED OFFICIALS SUBMITTING REQUEST – We certify that the form or other document submitted for approval is necessary for the proper performance of this agency's functions, that the information requested is not available from any other source, to the best of our knowledge, and that the request is consistent with applicable O.M.B. and agency policy directives. Signature and title of:

Approving official for agency	Date	Agency clearance officer or other agency official	Date

JUSTIFICATION OF HOUSEHOLD HEALTH SURVEY

1. Supporting Statement Justification

(1) This new questionnaire is required to obtain information on a population living near a sewage treatment plant to determine whether or not certain diseases are associated with the operation of sewage treatment plants. No forms of this type are currently available within the Environmental Protection Agency, or known from other agencies that meet the requirements of this design form. This questionnaire form is to be utilized on the EPA Contract No. 68-02-1746, SwRI Project entitled "Health Implications of Sewage Treatment Facilities." It has been shown that the operation of an activated sludge treatment plant does produce certain types of pathogens and trace metals which may be associated with the introduction of disease and residues of these trace metals in a nearby population. This questionnaire form would provide necessary information to guide the Environmental Protection Agency in its assessment of potential health effects associated with the operation of an activated sludge treatment plant. The questionnaire form will solicit information from 1,000 households to cover all individuals living in the household in regard to age, sex, chronic diseases, infectious diseases, and certain types of symptoms that may be related to these infectious diseases. The plan is to survey approximately 1,000 households prior to the operation of a new activated sludge treatment plant and to follow up the survey with an additional 1,000 households once

the plant has become operational. This project will be conducted as a contract with Southwest Research Institute under the technical direction of Dr. Donald E. Johnson. The attached statement from Southwest Research Institute provides more details on the plans for this survey.

(2) The data collected using this survey instrument and the follow-up statistical analysis will be utilized by the Environmental Protection Agency to assess the potential health hazards associated with the operation of an activated sludge treatment plant.

(3) Some preliminary data have been published in the literature relative to the operation of a sewage treatment plant near populated areas, however, this in-depth survey is required to obtain more definitive information.

2. Description of Survey Plan

(1) The survey design will be aimed at determining the disease incidence of a population living within 5 kilometers of an activated sludge treatment plant in populations within the United States. The survey will be directed at one typical sewage treatment plant and will provide an estimation of the types of data found. It is estimated that total population living within 5-kilometer radii of all activated sludge sewage treatment plants within the United States is over one million.

(2) The survey is designed to contact and survey 1,000 households selected at random within a 5-kilometer radius of a typical activated sludge

sewage treatment plant. The plant selected will have at least a population ten times greater than the 1,000 households needed. The survey designed provides for examination of 1,000 households prior to the operation of the activated sewage plant and a follow up study at least six months after the sewage plant has become operational. The intent of the study is to compare the incidence of certain diseases before and during the operation of a new activated sludge sewage treatment plant. The households will be contacted by a personal interview survey team in which the individual answering the door will be asked to answer questions for himself and all other members of the household. The completed questionnaires will be forwarded to the survey team and then appropriate statistical analyses will be made following completion of the two surveys of 1,000 households to correlate differences in incidence of diseases. A pre-test of the questionnaire has been conducted. This pre-test was conducted with five representative individuals from the staff at Southwest Research Institute, and no difficulties were encountered. The question of non-responders for this particular survey does not appear to represent a problem since the burden for the individuals at households to respond to this is minimal and number of non-responders is expected to be very low. Preliminary contact with representatives of the community to be surveyed indicates that this type of response will be obtained.

(3) The statistical design of the project will come primarily from Mr. David Camann with Southwest Research Institute. The Environmental

Protection Agency's statistician, ______________________________, has reviewed this protocol.

(4) Name of the Contractor: Southwest Research Institute. Contractor's role: the primary role is to collect information and provide a final report to include statistical evaluation of data and conclusions regarding the potential health effects related to the operation of an activated sludge sewage treatment plant with a disease survey.

Southwest Research Institute guarantees confidentiality of the collected data to the subjects surveyed. No direct reference to the collected data using the subject's name or address will be made. The compilation of subject's name and address will be maintained in a confidential file and will not be directly related to any of the collected data. Each subject surveyed will be assigned a code number and the coded number with the individual's name will be maintained only in the files of Dr. Donald E. Johnson, principal investigator, at Southwest Research Institute.

3. Time Schedule for Data Collection and Publication

(1) The contract is scheduled for two-year completion, including monthly reports followed by a comprehensive final report to be submitted on completion of the two-year study. Attached is a time schedule for the entire project. It is estimated that the elapsed time

between the completion of data collection and the issuance of the first published reports will be approximately one year.

4. Consultations Outside the Agency

Detailed consultations were conducted with Dr. Joe E. Ledbetter, Professor of Civil Engineering, University of Texas at Austin, regarding the overall design of the survey. Dr. Ledbetter has conducted some of the previous studies connecting certain disease incidence with the operation of activated sludge plants. Mr. Lee Hiser, L. L. Hiser and Associates, New Braunfels, Texas, has also been consulted with regard to the conduct of the survey. Mr. Hiser's expertise is primarily in the area of design and operation of sewage treatment facilities and his expertise was valuable in determining a typical activated sludge sewage treatment plant for use in the survey.

Consultation has also been made with the Metropolitan Sanitary District of Greater Chicago with Mr. Bart Lyman, its general superintendent. Additional consultations have been made with Mr. Raymond Rimkus, Chief of Maintenance and Operations, and Dr. Lue-Hing, Director of Research and Development of the Metropolitan Sanitary District of Greater Chicago for their cooperation and assistance in the conduct of the surveys near one of their activated sludge sewage treatment plants.

5. Estimation of Respondent Reporting Burden

The estimation of respondent reporting burden for the Household Health Survey is ten minutes. This estimate is based on a preliminary pre-test survey of randomly selected Southwest Research Institute employees and should be the amount of time necessary for even a large household to complete.

6. Sensitive Questions

Questions 5, 6, and 7 ask questions regarding recent state of health in the subjects of the household being surveyed. This information is essential in order to provide an assessment of the health effects associated with a sewage treatment plant. Questions 9, 10, 11, 12, 13 and 14 provide information about how long the individuals within the household have lived within the area to be studied which is relevant to the exposure time to the potential health hazards within the area. Other parts of these questions refer to some of the socio-economic background necessary to make valid statistical comparisons with other areas.

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STANDARD FORM NO. 83
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FOR O.M.B. USE

IMPORTANT – Submit the required number of copies of SF-83, together with the material for which approval is requested to:

CLEARANCE OFFICER
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

READ INSTRUCTIONS BEFORE COMPLETING FORM

PART A – REQUEST BY FEDERAL AGENCY FOR CLEARANCE

*Items marked with asterisk may be omitted for preliminary plans or recordkeeping requirements

1. SEND "NOTICE OF ACTION" TO: Name and mailing address

2. Bureau and division or office originating request

3. Name(s), title(s), and telephone numbers of person(s) who can best answer questions regarding request.

FORM OR DOCUMENT IDENTIFICATION

4. Title of form or document submitted
HEALTH SURVEY PARTICIPANT QUESTIONAIRE

*5. Agency Form Number(s)

6. Type of form or document
1 ☐ Application
2 ☐ Program evaluation
3 ☐ Other management report
4 ☐ Statistical survey or report
5 ☐ Preliminary plan or contract
6 ☐ Recordkeeping requirement
7 ☐ Other – *Specify*

7. Current (or former) O.M.B. clearance – Number
Expiration date

8. Requested expiration date

9. Type of request
1 ☒ New
2 ☐ Revision
3 ☐ Extension (No change)
4 ☐ Reinstatement

*10. Frequency of use
1 ☐ Single time
2 ☒ On occasion
3 ☐ Weekly
4 ☐ Monthly
5 ☐ Quarterly
6 ☐ Semi-annually
7 ☐ Annually
8 ☐ Other *(See instructions)*

11. Related forms or documents *(Give O.M.B. number. Enclose in parentheses any to be replaced.)*

12. Catalog of Federal Domestic Assistance program number (if applicable)

COLLECTION AND RESPONDENTS

*13a. Collection method *(Check as many as apply)*
1 ☐ Mail
2 ☒ Personal interview
3 ☐ Other – *Describe*

*13b. Collected by –
4 ☐ Agency
5 ☐ Contractor
6 ☐ Other – *Describe*

14a. Type of respondents involved *(Check predominant one)*
1 ☒ Individuals or households
2 ☐ Business firms (non-farm)
3 ☐ Farms
4 ☐ Government agencies
5 ☐ Other – *Describe*

14b. Brief description of respondents (i.e., "households in 50 largest SMSA's; "retail grocery stores")

*15. Summary of estimated respondent burden	Number
a. Estimated number of respondents	300
b. If sample, approximate number in universe	over 1 million
c. Reports filed annually by each respondent (item 10)	once
d. Total annual responses (a X c)	300
e. Estimated average number of man-hours required per response	1/2
f. Estimated TOTAL MAN-HOURS of respondent burden (d X e)	150

AUTHORITY AND CONFIDENTIALITY

*16a. Is re [illegible] form –
1 ☐ Voluntary?
2 ☒ Required to obtain benefit?
3 ☐ Mandatory? *Cite statute*

*16b. Does your agency pledge confidentiality?
1 ☒ Yes
2 ☐ No

CONSULTATIONS OUTSIDE AGENCY

17. In developing the report form or other documents, were consultations held with individuals or organizations outside your agency?
1 ☒ Yes – If "yes," identify persons and describe outcome in SUPPORTING STATEMENT. *(See instructions)*
2 ☐ No

CERTIFICATION BY AUTHORIZED OFFICIALS SUBMITTING REQUEST – We certify that the form or other document submitted for approval is necessary for the proper performance of this agency's functions, that the information requested is not available from any other source, to the best of our knowledge, and that the request is consistent with applicable O.M.B. and agency policy directives. Signature and title of:

Approving official for agency	Date	Agency clearance officer or other agency official	Date

JUSTIFICATION OF HEALTH SURVEY PARTICIPANT QUESTIONNAIRE

1. Supporting Statement Justification

(1) This new questionnaire is required to obtain information on a population living near a sewage treatment plant to determine whether or not certain diseases are associated with the operation of sewage treatment plants. No forms of this type are currently available within the Environmental Protection Agency, or known from other agencies that meet the requirements of this design form. This questionnaire form is to be utilized on the EPA Contract No. 68-02-1746, SwRI Project entitled "Health Implications of Sewage Treatment Facilities." It has been shown that the operation of an activated sludge treatment plant does produce certain types of pathogens and trace metals which may be associated with the introduction of disease and residues of these trace metals in a nearby population. This questionnaire form would provide necessary information to guide the Environmental Protection Agency in its assessment of potential health effects associated with the operation of an activated sludge sewage treatment plant. The questionnaire form will solicit health-related information from 200-240 individuals living in the study area in regard to age, sex, chronic diseases, infectious diseases, and certain types of symptoms that may be related to these infectious diseases. The plan is to survey and sample approximately 200-240 individuals prior to the operation of a new activated sludge treatment plant and to follow up the

survey with an additional 200-240 individuals once the plant has become operational. This project will be conducted as a contract with Southwest Research Institute under the technical direction of Dr. Donald E. Johnson. The attached statement from Southwest Research Institute provides more details on the plans for this survey.

(2) The data collected using this survey instrument and the follow-up statistical analysis will be utilized by the Environmental Protection Agency to assess the potential health hazards associated with the operation of an activated sludge sewage treatment plant.

(3) Some preliminary data have been published in the literature relative to the operation of a sewage treatment plant near populated areas, however, this in-depth survey is required to obtain more definitive information.

2. Description of Survey Plan

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(2) The survey is designed to initially contact and survey 1,000 households selected at random within a 5-kilometer radius of a typical activated sludge sewage treatment plant. The plant selected will have at least a population ten times greater than the 1,000 households needed. The survey designed provides for examination of 1,000 households prior to the operation of the activated sewage plant and a follow up study at least six months after the sewage plant has become operational. The intent of the study is to compare the incidence of certain diseases before and during the operation of a new activated sludge sewage treatment plant. The households will be contacted by a personal interview survey team in which the individual answering the door will be asked to answer questions forwarded to the survey team and then appropriate statistical analyses will be made following completion of the two surveys of 1,000 households to correlate differences in incidence of diseases. If the subject responds in the negative to question 10 of the Household Health survey: "Do you plan to move during the coming year?" and in the affirmative to question 15: "Would you participate in a health survey as a paid volunteer?" he will be issued a Health Survey Participant Questionnaire. It is anticipated that between 200 and 240 subjects who respond to this questionnaire will be chosen, on the basis of age and location categories, to participate as paid volunteers. Each subject will be sent a letter announcing that they have been selected for the survey;

a time and place will be specified as to when they should report for a first meeting and for sampling dates.

A pre-test of the questionnaire has been conducted. This pre-test was conducted with five representative individuals from the staff of Southwest Research Institute, and no difficulties were encountered. The question of non-responders for this particular survey does not appear to represent a problem since the burden for the individuals at households to respond to this is minimal and number of non-responders is expected to be very low. Preliminary contact with representatives of the community to be surveyed indicates that this type of response will be obtained.

(3) The statistical design of the project will come primarily from Mr. David Camann with Southwest Research Institute. The Environmental Protection Agency's statistician, ______________________________, has reviewed this protocol.

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Consultation has also been made with the Metropolitan Sanitary District of Greater Chicago with Mr. Bart Lyman, its general superintendent. Additional consultations have been made with Mr. Raymond Rimkus, Chief of Maintenance and Operations, and Dr. Lue-Hing, Director of Research and Development of the Metropolitan Sanitary District of Greater Chicago for their cooperation and assistance in the conduct of the surveys near one of their activated sludge sewage treatment plants.

5. Estimation of Respondent Reporting Burden

The estimation of respondent reporting burden for the Health Survey Participant Questionnaire is six minutes. This estimate is based upon a preliminary pre-test survey of randomly selected Southwest Research Institute employees, and should be the amount of time necessary even if all members of a given household choose to participate in the health survey and sampling program.

6. Sensitive Questions

Questions 5, 6, 7, 8, 18 and 19 provide background information on individuals that will be utilized for correlation with other studies and for making estimates with regard to general populations at risk. Question 9 asks the subject about how many hours of the day he normally spends more than 2 miles from his home. This question is required to obtain some estimate of the total time the individuals spend within the study area. Question 10 asks what is the natural color of respondent's hair. This information is needed because it has been shown that the natural color of an individual's hair will affect the levels of certain trace metals found in hair. Since it is a part of the study to analyze trace metals in hair samples, this information is essential. Questions 11 and 12 ask about the cigarette smoking status of the individual. This information is needed for correlation with several parameters, but one includes trace metal information since it has been shown that cigarette smoking does provide a different profile of certain metals such as cadmium in cigarette smokers versus non-smokers. Questions 13, 14 and 15 will provide an assessment of how long the subjects have lived within the survey area and how long they plan to continue living in the area. This information is needed both for purposes of estimating the length of exposure of subjects to the sewage treatment plant and to establish a stable survey population over the 18-month period required. Question 16 asks about chronic illnesses and certain medications that the subject may be taking with regard to these illnesses. It is necessary to obtain information regarding chronic illnesses in order to provide an assessment of the type of population being surveyed with comparison to populations in other areas of the country. Additionally, it is necessary since some trace metal surveys have shown that certain chronic diseases significantly affect trace metal levels in different tissues. Also, the medication taken by the individual has been shown to affect these levels, thus this type of correlation would be of importance. Question 17 relates to home air conditioning. Since it is anticipated that the major avenue of transport of certain pathogens and trace metals from the sewage treatment plant to the population is via ambient air, it is important to know whether or not the subject has air conditioning, since this will affect this relationship.

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WASHINGTON, D.C. 20503

READ INSTRUCTIONS BEFORE COMPLETING FORM

PART A – REQUEST BY FEDERAL AGENCY FOR CLEARANCE

*Items marked with asterisk may be omitted for preliminary plans or recordkeeping requirements

1. SEND "NOTICE OF ACTION" TO: Name and mailing address

2. Bureau and division or office originating request

3. Name(s), title(s), and telephone numbers of person(s) who can best answer questions regarding request.

FORM OR DOCUMENT IDENTIFICATION

4. Title of form or document submitted
CURRENT HEALTH STATUS QUESTIONNAIRE

*5. Agency Form Number(s)

6. Type of form or document
1 ☐ Application
2 ☐ Program evaluation
3 ☐ Other management report
4 ☐ Statistical survey or report
5 ☐ Preliminary plan or contract
6 ☐ Recordkeeping requirement
7 ☐ Other – *Specify*

7. Current (or former) O.M.B. clearance – Number

Expiration date

8. Requested expiration date

9. Type of request
1 ☒ New
2 ☐ Revision
3 ☐ Extension (No change)
4 ☐ Reinstatement

*10. Frequency of use
1 ☐ Single time
2 ☒ On occasion
3 ☐ Weekly
4 ☐ Monthly
5 ☐ Quarterly
6 ☐ Semi-annually
7 ☐ Annually
8 ☐ Other *(See instructions)*

11. Related forms or documents *(Give O.M.B. number. Enclose in parentheses any to be replaced.)*

12. Catalog of Federal Domestic Assistance program number (if applicable)

COLLECTION AND RESPONDENTS

*13a. Collection method *(Check as many as apply)*
1 ☐ Mail
2 ☒ Personal interview
3 ☐ Other – *Describe*

*13b. Collected by –
4 ☐ Agency
5 ☐ Contractor
6 ☐ Other – *Describe*

14a. Type of respondents involved *(Check predominant one)*
1 ☒ Individuals or households
2 ☐ Business firms (non-farm)
3 ☐ Farms
4 ☐ Government agencies
5 ☐ Other – *Describe*

14b. Brief description of respondents (i.e., "households in 50 largest SMSA's; "retail grocery stores")

*15. Summary of estimated respondent burden	Number
a. Estimated number of respondents	150
b. If sample, approximate number in universe	over 1 million
c. Reports filed annually by each respondent (item 10)	4
d. Total annual responses (a X c)	600
e. Estimated average number of man-hours required per response	1/2
f. Estimated TOTAL MAN-HOURS of respondent burden (d X e)	300

AUTHORITY AND CONFIDENTIALITY

*16a. Is report form –
1 ☐ Voluntary?
2 ☒ Required to obtain benefit?
3 ☐ Mandatory? *Cite statute*

*16b. Does your agency pledge confidentiality?
1 ☒ Yes
2 ☐ No

CONSULTATIONS OUTSIDE AGENCY

17. In developing the report form or other documents, were consultations held with individuals or organizations outside your agency?
1 ☒ Yes – If "yes," identify persons and describe outcome in SUPPORTING STATEMENT. *(See instructions)*
2 ☐ No

CERTIFICATION BY AUTHORIZED OFFICIALS SUBMITTING REQUEST – We certify that the form or other document submitted for approval is necessary for the proper performance of this agency's functions, that the information requested is not available from any other source, to the best of our knowledge, and that the request is consistent with applicable O.M.B. and agency policy directives. Signature and title of:

Approving official for agency	Date	Agency clearance officer or other agency official	Date

JUSTIFICATION OF CURRENT HEALTH STATUS QUESTIONNAIRE

1. Supporting Statement Justification

(1) This new questionnaire is required to obtain information on a population living near a sewage treatment plant to determine whether or not certain diseases are associated with the operation of sewage treatment plants. No forms of this type are currently available within the Environmental Protection Agency, or known from other agencies that meet the requirements of this design form. This questionnaire form is to be utilized on the EPA Contract No. 68-02-1746, SwRI Project entitled "Health Implications of Sewage Treatment Facilities." It has been shown that the operation of an activated sludge sewage treatment plant does produce certain types of pathogens and trace metals which may be associated with the introduction of disease and residues of these trace metals in a nearby population. This questionnaire form would provide necessary information to guide the Environmental Protection Agency in its assessment of potential health effects associated with the operation of an activated sludge sewage treatment plant. The questionnaire is designed to determine the type of medication sample volunteers may be taking and the type of diseases that may be prevalent in the study group. It will also record the symptoms that the subject has experienced during the previous 3 months. This information will be used to assist in determining the incidence of disease in the study group. This project will be conducted as a contract with Southwest

Research Institute under the technical direction of Dr. Donald E. Johnson. The attached statement from Southwest Research Institute provides more details on the plans for this survey.

(2) The data collected using this survey instrument and the follow-up statistical analyses will be utilized by the Environmental Protection Agency to assess the potential health hazards associated with the operation of an activated sludge sewage treatment plant.

(3) Some preliminary data have been published in the literature relative to the operation of a sewage treatment plant near populated areas; however, this in-depth survey is required to obtain more definitive information.

2. Description of Survey Plan

(1) The survey design will be aimed at determining health incidence of a population living within 5 kilometers of an activated sludge sewage treatment plant in populations within the United States. The survey will be directed at one typical sewage treatment plant and will provide an estimation of the types of data found. It is estimated that the total population living within 5-kilometer radii of all activated sludge sewage treatment plants within the United States is over one million.

(2) 200-240 subjects will be chosen from the respondents to the Health Survey Participation Questionnaire whose participation was

solicited from the initial Household Health Survey Questionnaire. The Current Health Status Questionnaire will be completed by each subject completing a sampling period. Thus, if the subject has completed the full protocol, he will have provided four samples of urine, blood, feces, throat swab, sputum, hair and have completed the current health status questionnaire four times. A pre-test of the questionnaire has been conducted. This pre-test was conducted with five representative individuals from the staff at Southwest Research Institute, and no difficulties were encountered. The question of non-responders for this particular survey does not appear to be a problem since those individuals asked to complete the questionnaire have already evidenced their willingness to participate in a sampling program.

(3) The statistical design of the project will come primarily from Mr. David Camann with Southwest Research Institute. The Environmental Protection Agency's statistician, ______________________________, has reviewed this protocol.

(4) Name of the Contractor: Southwest Research Institute, Contractor's role: the primary role is to collect information and provide a final report to include statistical evaluation of data and conclusions regarding the potential health effects related to the operation of an activated sludge sewage treatment plant with a disease survey.

Southwest Research Institute guarantees confidentiality of the collected data to the subjects surveyed. No direct reference to the collected data using the subject's name or address will be made. The compilation of subject's name and address will be maintained in a confidential file and will not be directly related to any of the collected data. Each subject surveyed will be assigned a code number and the coded number with the individual's name will be maintained only in the files of Dr. Donald E. Johnson, principal investigator, at Southwest Research Institute.

3. Time Schedule for Data Collection and Publication

(1) The contract is scheduled for two-year completion, including monthly reports followed by a comprehensive final report to be submitted on completion of the two-year study. Attached is a time schedule for the entire project. It is estimated that the elapsed time between the completion of data collection and the issuance of the first published reports will be approximately one year.

4. Consultations Outside the Agency

Detailed consultations were conducted with Dr. Joe E. Ledbetter, Professor of Civil Engineering, University of Texas at Austin, regarding the overall design of the survey. Dr. Ledbetter has conducted some of the previous studies connecting certain disease incidence with the operation of activated sludge plants. Mr. Lee Hiser, L. L. Hiser and Associates, New Braunfels, Texas, has also been consulted with regard to the conduct of the survey. Mr. Hiser's expertise is primarily in the area of design and operation of sewage treatment facilities and his expertise was valuable in determining a typical activated sludge sewage treatment plant for use in the survey.

Consultation has also been made with the Metropolitan Sanitary District of Greater Chicago with Mr. Bart Lyman, its general superintendent. Additional consultations have been made with Mr. Raymond Rimkus, Chief of Maintenance and Operations, and Dr. Lue-Hing, Director of Research and Development of the Metropolitan Sanitary District of Greater Chicago for their cooperation and assistance in the conduct of the surveys near one of their activated sludge sewage treatment plants.

5. Estimation of Respondent Reporting Burden

The estimation of respondent reporting burden for the Current Health Status Questionnaire is six minutes. This estimate is based on a preliminary pre-test of randomly selected Southwest Research Institute employees.

6. Sensitive Questions

All of the questions on the Health Status Questionnaire, except for the first question, may be considered sensitive. Questions 2, 3, and 4 ask about chronic illnesses and/or diagnosed diseases and certain medications the subject may be taking with regard to their illnesses. It is necessary to obtain information regarding chronic illnesses and/or diagnosed diseases in order to provide an assessment of the subject's state of health, both before the sewage treatment plant becomes operational and after it is on-line. Additionally, it is necessary since some trace metal surveys have shown that certain chronic diseases significantly affect trace metal levels in different tissues. Medication taken by individuals has been shown to affect trace metal levels, making this type of correlation important. Question 5 relates to recent symptoms experienced by the subject. This information is essential in order to provide an assessment of the health effects associated with a sewage treatment plant.

APPENDIX B

SURVEY BACKUP MATERIALS

Recruitment handouts, interviewer instruction and information sheets, and the news release used to generate public awareness of the program are presented in this Appendix.

HOW ABOUT AN EXTRA $75?

WE NEED 250 PAID VOLUNTEERS FOR A RESEARCH STUDY

Summary

As you may be aware, the Metropolitan Sanitary District of Greater Chicago is constructing an advanced wastewater reclamation facility on Salt Creek, adjacent to your community. Southwest Research Institute (SwRI) of San Antonio, Texas is performing a study for the U. S. Environmental Protection Agency (EPA) on the possible incidence of disease resulting from the operation of sewage treatment plants. Although no unusual incidence of disease from the operation of the Salt Creek Plant is anticipated, SwRI will be collecting air, soil, and water samples within the study area shown on the map. Additionally, samples of blood, urine, feces, sputum and hair clippings will be taken from paid volunteers.

Participants Needed

250 participants, both male and female, are needed, age requirements being 3 months to any interested elderly.

Samples Needed from Each Volunteer Participant

Four sampling periods will span eighteen months necessitating:

(1) Four overnight urine samples
(2) Four overnight fece samples
(3) Four blood samples
(4) Four hair samples
(5) Four sputum samples

Sample Collection

Four sampling periods will span an eighteen-month period beginning, tentatively, October 14, 1974. Volunteers will be chosen from a Household Health Survey conducted September 23 through 27, 1974. Those volunteers fitting appropriate age and locational categories will be notified by mail of their selection and where to meet for orientation and provision of sample containers. Medical personnel will collect the blood and sputum samples and a professional barber will collect the hair samples.

Payment for Volunteer Participants

Each complete sampling period will earn each participant $12.50. For those completing all four sampling periods, a bonus of $25 will be paid. Participants in all four sampling periods can earn $75. A family of four can earn $300.

WORTH $75 TO EACH PARTICIPANT

INTERVIEWER HANDOUT-INNER SECTORS

Introduction and Summary

Hello, my name is _________________________ and I represent Southwest Research Institute which is under contract to the U. S. Environmental Protection Agency. SwRI is conducting a study to assess the health effects resulting from the operation of sewage treatment plants.

As you may be aware, the Metropolitan Sanitary District of Greater Chicago is constructing an advanced wastewater reclamation facility on Salt Creek adjacent to your community. Although no unusual incidence of disease from the operation of the Salt Creek Plant is anticipated, SwRI will be collecting air, soil, and water samples within your community to obtain baseline information. Additionally, SwRI is conducting this Household Survey to obtain further information on the Household incidence of disease before the Salt Creek Plant becomes operational. After the plant is operational, a second survey will be performed with the results of both being compared.

Individual Health Participant Survey

Your household is in an area of particular interest for our study. We would like to know if you would be interested in being a paid participant in an individual health survey. If you are interested, this information sheet explains what the individual health survey is all about.

We can fill out this participant questionnaire now, or I can leave it with you for later retrieval by me this week, or you can mail it to SwRI with the enclosed, self addressed, stamped envelope no later than September 28, 1974.

All members of your household can participate, so I will leave you sufficient participant questionnaires for your whole family.

INTERVIEWER INFORMATION - PARTICIPANT SECTORS

SUMMARY

Southwest Research Institute of San Antonio, Texas, under contract to the U. S. Environmental Protection Agency, and in cooperation with the Metropolitan Sanitary District of Greater Chicago, will be conducting a study to assess the health effects resulting from the operation of sewage treatment plants. Focus of the study is a three-mile radius area surrounding the Salt Creek Water Reclamation Plant presently under construction by the Metropolitan Sanitary District of Greater Chicago. In this study, air, water, and soil samples will be gathered and analyzed and the incidence of disease in people within the study area will be monitored to establish a baseline. After the plant becomes operational, further sampling and monitoring will take place for comparison.

YOUR PART

You, as an interviewer, are a key element in the success of this study. Your contact with the members of the community in your assigned sector will provide two very essential features. Your first and primary function is to obtain public health information through the completed household questionnaire forms. Each interviewer is expected to obtain at least fifty completed forms. Secondly, during the course of each interview, a solicitation is made for attracting the needed paid volunteers. Two hundred and fifty paid volunteers are needed for a successful study, and you will receive a bonus for each volunteer you obtain (completed Health Survey Participant Questionnaire forms).

INSTRUCTIONS

If the respondant replies in the negative to question 10, and in the positive to question 15, on the Household Health Survey, you will provide him with a copy(ies) of the Health Survey Participant Questionnaire which the participant(s) will fill out immediately if time permits. If it is more convenient, arrange to pick the completed form(s) up at a later time. In all cases, interested participants will receive informational forms.

Note: The information listed under : "Interviewer Note and Record" must be completed for each form. Distance and sector information will be indicated on the sector maps provided to you. It is particularly importent to fill out this information on the "Health Survey Participant Questionnaire" forms left with potential participants. Completed forms need to be coded and turned in daily, at the end of the day or at the beginning of the next day. This will allow proper logging and inspection of the forms in an orderly manner by the survey team leader.

PAYMENT

Each interviewer will be paid for working a forty-hour week. At least fifty (50) forms are expected from each interviewer, completed and properly coded. For Health Survey Participant forms, a bonus of as much as $4.00 per form will be paid. $1000 has been set aside for 250 forms at $4.00 each. If more than 250 volunteers are obtained, the $1000 will be prorated accordingly. (Example: A total of 333 volunteers would place the bonus at $3.00 per form). You will be paid by Manpower, Inc. for the 40 hour week. You will be paid directly by SwRI for any bonus you earn.

INTERVIEWER INFORMATION - OUTLYING SECTORS

SUMMARY

Southwest Research Institute of San Antonio, Texas, under contract to the U. S. Environmental Protection Agency, and in cooperation with the Metropolitan Sanitary District of Greater Chicago, will be conducting a study to assess the health effects resulting from the operation of sewage treatment plants. Focus of the study is a three-mile radius area surrounding the Salt Creek Water Reclamation Plant presently under construction by the Metropolitan Sanitary District of Greater Chicago. In this study, air, water, and soil samples will be gathered and analyzed and the incidence of disease in people within the study area will be monitored to establish a baseline. After the plant becomes operational, further sampling and monitoring will take place for comparison.

YOUR PART

You, as an interviewer, are a key element in the success of this study. Your contact with the members of the community in your assigned sector will provide public health information through the completed household questionnaire forms. Each interviewer is expected to obtain at least fifty completed forms.

INSTRUCTIONS

If the respondant replies in the negative to question 10, and in the positive to question 15, on the Household Health Survey, you will provide him with a copy of the informational forms. Encourage the individuals as much as possible to volunteer; this information is very valuable to the success of the study.

Note: The information listed under: "Interviewer Note and Record" must be completed for each form. Distance and sector information will be indicated on the sector maps provided to you. Completed forms need to be coded and turned in daily, at the end of the day or at the beginning of the next day. This will allow proper logging and inspection of the forms in an orderly manner by the survey team leader.

PAYMENT

Each interviewer will be paid for working a forty-hour week. At least fifty(50) forms are expected from each interviewer, completed and properly coded. You will be paid by Manpower, Inc. for the 40 hour week.

NEWS RELEASE

Southwest Research Institute of San Antonio, Texas, under contract to the U. S. Environmental Protection Agency, and in cooperation with the Metropolitan Sanitary District of Greater Chicago, will be conducting a study to assess the health effects resulting from the operation of sewage treatment plants. The focus of the study is a three-mile circular area (see map) surrounding the Salt Creek Water Reclamation Plant under construction by the Metropolitan Sanitary District of Greater Chicago.

The project will obtain baseline information by gathering air, water, and soil samples, and monitoring the incidence of disease in people within the study area. After the plant becomes operational, further sampling and monitoring will take place for comparison.

The study area encompasses portions of Schaumburg and Elk Grove Townships in Cook County, and Bloomingdale and Addison Townships in DuPage County. The areas of Schaumburg, Hoffman, Estates, Rolling Meadows, Elk Grove Village, Itasca, and Roselle, which fall within the study boundaries will be surveyed on a house-to-house basis with the tentative survey date set as September 9-13, 1974. Based upon the Household Health Survey, volunteers will be selected to participate in an individual health survey. Individual volunteers will be paid for participation in a sampling program which will span approximately eighteen months, tentatively scheduled for commencement on September 30, 1974. Of 1,000 households surveyed, SwRI hopes to obtain 250 volunteers.

Four samplings will be taken at various time intervals, with volunteers receiving $12.50 for each sampling period. A volunteer participating in all four samplings can earn a total of fifty dollars.

APPENDIX C

LETTERS OF ACCEPTANCE/NON-ACCEPTANCE TO SURVEY PARTICIPANTS

The letters to individuals advising them of whether they had been selected as participants are presented in this Appendix.

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SOUTHWEST RESEARCH INSTITUTE
8500 CULEBRA ROAD • POST OFFICE DRAWER 28510 • SAN ANTONIO, TEXAS 78284

Division of Chemistry
and Chemical Engineering

August 22, 1975

Dear Survey Participant:

The questionnaire, which you recently completed for Mrs. Carol McArthur, has been reviewed,and you have been selected for our research program. This is an important environmental study being conducted by Southwest Research Institute under contract to the U. S. Environmental Protection Agency, and, without the help of volunteers such as you, could not be conducted. Your participation is very much appreciated.

The survey team will be collecting samples on September 4, 5, and 6, 1975. To make the sampling as convenient for you as possible, we are trying to make arrangements to collect these samples at the Lexington Green. You will be notified on August 28 or 29 regarding the exact times and location for sampling. The total time required for your participation will be kept as short as possible (20 minutes total),and you will receive your money at the time of sample collections.

Mrs. Carol McArthur (894-5577) will be contacting you for further information. If you plan to be out of town on these dates, please notify us.

Yours very truly,

Donald E. Johnson, Ph.D.
Project Manager,
Environmental Survey Team

SAN ANTONIO, HOUSTON, CORPUS CHRISTI, TEXAS, AND WASHINGTON, D.C.

SOUTHWEST RESEARCH INSTITUTE
8500 CULEBRA ROAD • POST OFFICE DRAWER 28510 • SAN ANTONIO, TEXAS 78284

Division of Chemistry and
Chemical Engineering

August 22, 1975

Dear Survey Participant:

The questionnaire which you recently completed for Mrs. Carol McArthur has been reviewed by our staff. The requirements of this important environmental survey conducted by Southwest Research Institute under contract to the U. S. Environmental Protection Agency are many. One such requirement for this study is the number of people which can be selected in a particular age group. An over abundance of questionnaires were completed for your particular age group. Therefore, we could not include all of these in the study, and this is the reason for your not being selected.

Your questionnaire will be set aside for the present. However, should any other participant in your age category withdraw from the survey, you shall be contacted to fill this vacancy.

Your willingness to participate in the study is appreciated.

Very truly yours,

Donald E. Johnson
Project Manager
Environmental Survey Team

DEJ:pb

SAN ANTONIO, HOUSTON, CORPUS CHRISTI, TEXAS, AND WASHINGTON, D.C.

APPENDIX D

VOLUNTEER'S INFORMED CONSENT FORM

The form executed by the volunteers indicating that they were informed of the nature of the study and gave consent to participating in it is presented in this Appendix.

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VOLUNTEER'S INFORMED CONSENT

I, ______________________________

residing at ______________________________

____

hereby acknowledge and certify to the following:

1. That I hereby volunteer and consent to participate as a human test subject in an experiment designed to determine exposure to environmental pollutants entitled, "Health Implications of Sewage Treatment Facilities".

2. That I have been given, in my opinion, an adequate explanation of the nature,duration and purpose of the experiment, the means by which the experiment will be conducted and any possible inconveniences, hazards, discomforts, risks, and adverse effects on my health which could result from my participation therein;

3. That I have been informed of all appropriate alternative procedures, if any exist, that might be advantageous to me;

4. That I understand my questions concerning procedures which affect me will be answered fully and promptly;

5. That I understand that I have the right to withdraw my consent and to discontinue participation in this experiment at any time without prejudice regardless of the status of the experiment and regardless of the effect of such withdrawal on the objectives and results which the experiment is designed to achieve; and I also understand that my participation in the experiment may be terminated at any time by the investigator in charge of the project or the physician supervising the project regardless of my wishes to the matter;

6. That I hereby understand and agree that the samples collected from me will be analyzed for their content of trace metals, bacterial, and viral pathogens and that these are the only tests that will be made on these samples and that no medicinal compounds will be analyzed.

over

7. That I attained the age of _____ years on my last birthday which was ____, and that I am executing this Volunteer's Informed Consent as my free act and deed.

Executed this ______th day of ________________________, 19___.

Executed in my presence and in the presence of each other.

____
Witness

____
Volunteer

____
Person informing volunteer and obtaining volunteer's consent

If subject is a minor, complete the following:
Subject is a minor - age __________.

____
Father

____
Mother

____
Guardian

____
Other person and relationship

____

APPENDIX E

INSTRUCTION SHEET

The instruction sheet given to the participants advising them of proper collection techniques for the clinical samples is presented in this Appendix.

SOUTHWEST RESEARCH INSTITUTE
8500 CULEBRA ROAD • POST OFFICE DRAWER 28510 • SAN ANTONIO, TEXAS 78284

INSTRUCTION SHEET

The success of this research project depends on your complete cooperation. Only through the assistance of volunteers, such as you, can we obtain information on environmental pollutants. Your samples will also provide a free check on your current health status. Incomplete sampling of urine, feces and sputum will produce incomplete information, so please follow these instructions.

Urine Collection

(1) You will be given a urine collection bottle that has been cleaned in a special manner. Please avoid introducing anything else into this bottle other than urine.

(2) Beginning in the evenings (approximately 5:00 P.M.), you will begin collecting all of your urine in the container provided. Please urinate into this container each time you urinate until approximately 8:00 A.M. the next morning.

(3) The collection bottle should be capped tightly after each use.

Feces Collection

(1) You will also be given a collection container for feces that has been cleaned in a special manner. Your feces will be the only contents placed in this container.

(2) The portable toilet bag assembly has been provided for your convenience in feces collection. Open the sample bag and place it on the portable seat as shown in the instructions included with the kit. As with the urine collection, begin collecting all of your feces at approximately 5:00 P.M. and continue until the following morning.

(3) When collecting your specimen, be sure not to mix any urine or toilet paper with the feces. Analysis cannot be done on a sample that has been mixed with urine or paper. Also, take great care not to contaminate the outside of the collection vessel with feces because there may be potentially serious consequences to those handling the specimen. The specimen bag is to be sealed with the twist ties and then placed in the polyethylene container designated for feces.

...over, please.

SAN ANTONIO, HOUSTON, CORPUS CHRISTI, TEXAS, AND WASHINGTON, D.C.

(4) There is no restriction on your diet. You can eat or drink anything you wish, and you can eat breakfast before coming to work in the morning.

Sputum Collection

(1) You will be given a collection container that has been cleaned in a special manner for your sputum. Remove the lid from this container only when collecting your sputum and then immediately replace the lid.

(2) Upon arising in the morning, cough deeply at least several times. The material collected on the back of the tongue or in the mouth is to be placed in the container provided.

If you are unsuccessful in producing a specimen after coughing deeply, lie across a bed with your head and chest slanting downward toward the floor for 10 or 15 minutes. Coughing after this procedure will very likely result in producing an acceptable specimen for collection.

Current Health Status Questionnaire

Please fill out the questionnaire at home. This will save time at the collection center.

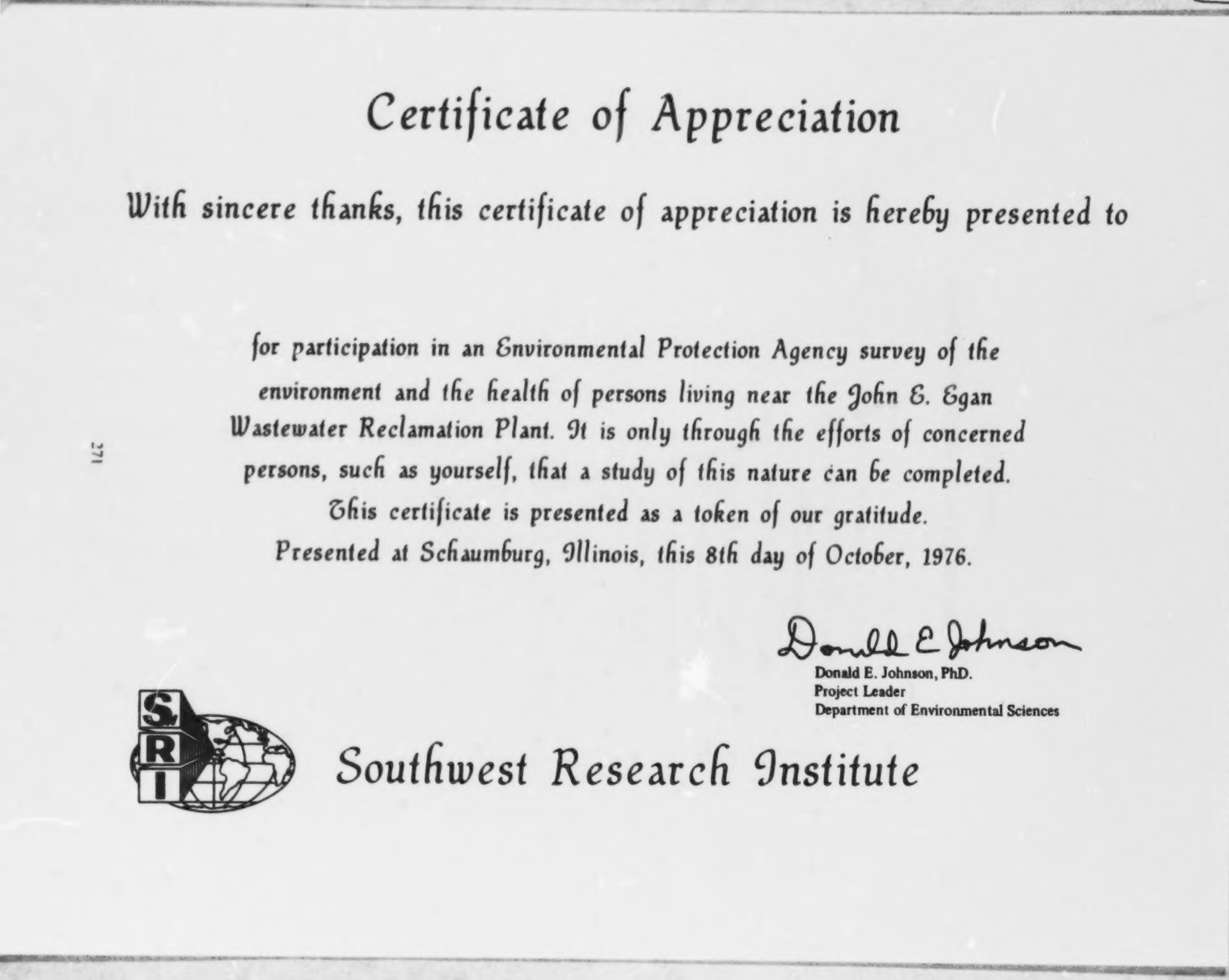
Please report to the collection center at the time designated for blood, hair and throat swab collections. Please bring your urine, feces and sputum specimens and the completed current Health Status Questionnaire with you.

Thank you very much for your help.

APPENDIX F

CERTIFICATION OF APPRECIATION

A copy of the certificate given to each study participant is presented in this Appendix.



Certificate of Appreciation

With sincere thanks, this certificate of appreciation is hereby presented to

for participation in an Environmental Protection Agency survey of the environment and the health of persons living near the John E. Egan Wastewater Reclamation Plant. It is only through the efforts of concerned persons, such as yourself, that a study of this nature can be completed.

This certificate is presented as a token of our gratitude.

Presented at Schaumburg, Illinois, this 8th day of October, 1976.

Donald E Johnson

Donald E. Johnson, PhD.
Project Leader
Department of Environmental Sciences

Southwest Research Institute

APPENDIX G

TYPICAL CODED DATA REPORTING FORMS

Table	Title
A-1	AEROSOL RUN REPORT ON METEOROLOGY AND SAMPLING CONFIGURATION
A-2	UTSA-CART AEROSOL RUN ANALYSIS REPORT
A-3	HOUSEHOLD HEALTH SURVEY
A-4	HEALTH SURVEY PARTICIPANT QUESTIONNAIRE
A-5	CURRENT HEALTH STATUS QUESTIONNAIRE
A-6	METAL ANALYSIS CODING FORM
A-7	PATHOGEN ANALYSIS CODING FORM
A-8	PATHOGEN ANALYSIS DATA FORM

TABLE A-1 AEROSOL RUN REPORT ON METEOROLOGY AND SAMPLING CONFIGURATION

Project 01-4007 Chicago, Illinois

Aerosol Run Number 3

Location John E. Egan STP

Run Date October 4, 1976

Field Supervisor JMT

	Beginning of Sampling	End of Sampling
Time	0600	0630
Estimated wind angle θ	90°	90°
Estimated pasquill stability class	E +4.275	E 3.9
Estimated cloud cover	None	1/9
Wind velocity from weather station mph	0-1	0-1
Temperature from weather station °F	52	52
Relative humidity from weather station %	76%	90%
Temperature of effluent		

Sampler Distance in Meters	LVAS Sampler Number	Personnel Running Samplers
Upwind	8	[redacted]
25	3	[redacted]
50	2	[redacted]
100	5	[redacted]
225	7	[redacted]
1000	4	[redacted]

Remarks:

Wind direction SSE. Very low speed Only a drift.
Two smoke bombs lit and both drifted in a SSE direction

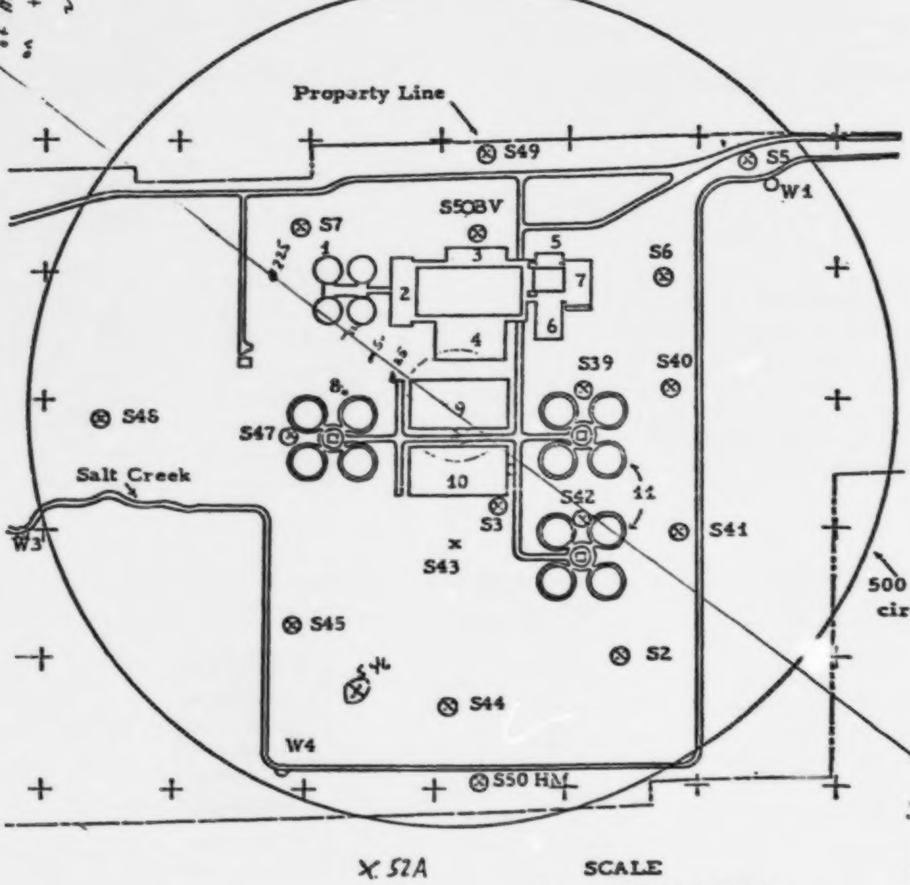
(continued)

TABLE A-1 (continued)

Aerosol Run #3

SALT CREEK WATER RECLAMATION PLANT
Soil and Water Sampling Sites

Salinas at corner of Meacham and Schaumb on the south east side ≈ 1000 meters



Property Line
S49
S5
W1
S50BV
S7
S6
1
2
3
4
5
6
7
225
8
9
10
11
S39
S40
S46
S47
Salt Creek
S42
S41
W3
S3
S43
S45
S2
S46
S44
W4
S50 HM
500 meter circle
X S2A

upwind
set up on feeder street to thru S2 near gas line easement

SCALE
1cm ≃ 60 METERS

Key

1. Digesters	8. Settling Tanks No. 1
2. Thickener Building	9. Aeration Basins No. 1
3. Maintenance Building	10. Aeration Basins No. 2
4. Pretreatment Building	11. Settling Tanks No. 2
5. Control Building	⊗ Soil Sampling Site
6. Laboratory Building	○ Water Sampling Site
7. Filter Building	

(continued)

TABLE A-1 (continued)

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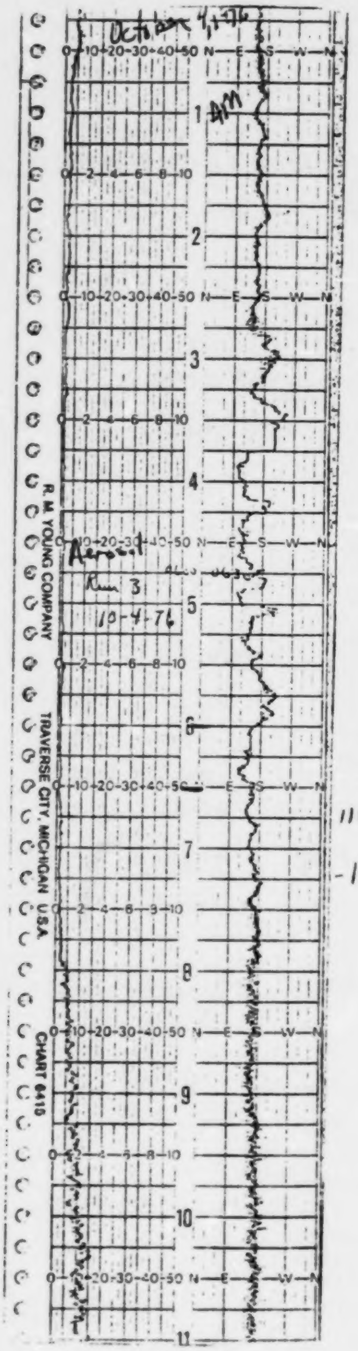


'25

110 – 165°

-15°; 40°

TABLE A-2 UTSA-CART AEROSOL RUN ANALYSIS REPORT

1 of 2

Date Reported ________

Run Number 10

Run Date and Time 10/8/76

Reports to: David Camann, San Antonio
James Register,

Wastewater Analysis:

SwRI Label Code. 10 SS CH5

Total Coliphage Count 5.1×10^4 pfu/l

Solids Fraction 4.5×10^4 pfu/l

Liquid Fraction 5.6×10^3 pfu/l

Aerosol Analysis:

Sampler	1	2	4	5
SwRI Label Code	1 10 AVCH5	2 10 AVCH5	4 10 AVCH5	5 10 AVCH5
Bacteria				
Proteus	<500 (ND)	* <500(ND)	β, γ, + <500(ND)	** <500(ND)
Pseudomonas, cfu/100ml	2.4×10^5	5.0×10^3	<500(ND)	1.5×10^4
Streptococcus, cfu/100ml	<500(ND)	<500(ND)	<500 (ND)	<500(ND)
Salmonella, cfu/100ml	<500(ND)	<500(ND)	<500(ND)	<500(ND)
Shigella, cfu/100ml	<500 (ND)	<500(ND)	<500(ND)	<500(ND)
Viruses				
3 Day Plaque Count, pfu/ml	<0.08(ND)	<0.07(ND)	<0.08(ND)	CS
5 Day Plaque Count, pfu/ml	<0.17(ND)	<0.17(ND)	<0.21(ND)	CS
Coliphage				
Coliphage Count, pfu/ml	<0.05(ND)	<0.05(ND)	0.05	0.10

COMMENTS:

** Escherichia - 1.0×10^3 cfu/100ml
β Escherichia - 1.7×10^4 cfu/100ml
+ Providencia isolated
γ Klebsiella isolated
* Citrobacter freundii - 5.0×10^3 cfu/100ml; Enterobacter - 1.2×10^5 cfu/100ml

NOTATION: TNTC-too numerous to count
ND-none detected
CS-contaminated sample

(continued)

TABLE A-2 (continued)

2 of 2

Run No. 10

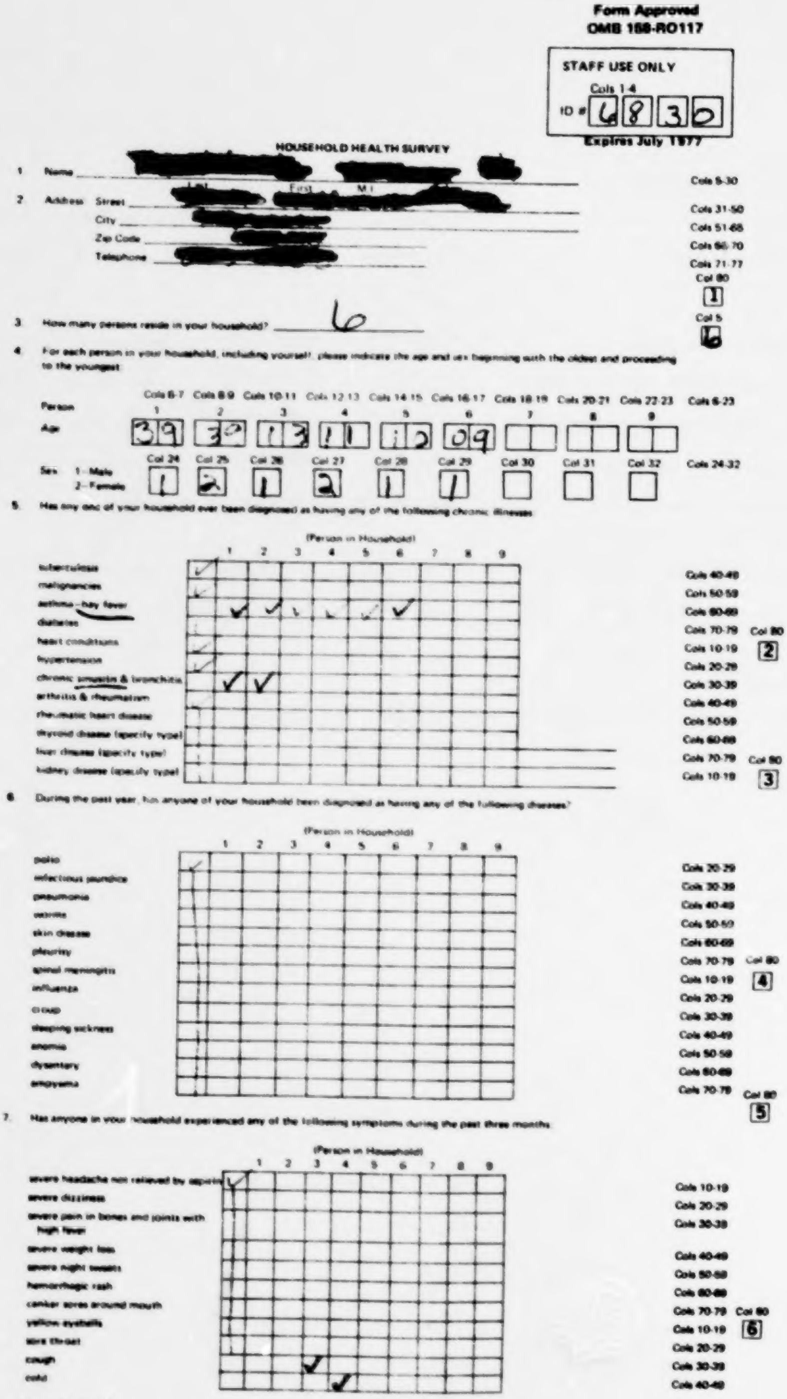
Aerosol Analyses:				
Sampler	7	8		
SwRI Label Code	710AVCH5	810AVCH5		
Bacteria				
Proteus, cfu/100ml	+ <500(ND)	<500(ND)		
Psuedomonas, cfu/100ml	2.1×10^5	<500(ND)		
Streptococcus, cfu/100ml	<500(ND)	<500(ND)		
Salmonella, cfu/100ml	<500(ND)	<500(ND)		
Shigella, cfu/100ml	<500(ND)	<500(ND)		
Viruses				
3 Day Plaque Count, pfu/ml	<0.07(ND)	<0.06(ND)		
5 Day Plaque Count, pfu/ml	<0.14(ND)	<0.14(ND)		
Coliphage				
Coliphage Count, pfu/ml	<0.05(ND)	<005(ND)		

COMMENTS:

⊕ - Enterobacter – 8.2×10^4 cfu/100 ml

NOTATION: TNTC-too numerous to count
ND-none detected
CS-contaminated sample

TABLE A-3 HOUSEHOLD HEALTH SURVEY



Form Approved
OMB 158-RO117

STAFF USE ONLY
Cols 1-4
ID # 6 8 3 0
Expires July 1977

HOUSEHOLD HEALTH SURVEY

1 Name [redacted] Cols 5-30
Last First M.I.

2 Address Street [redacted] Cols 31-50
City [redacted] Cols 51-65
Zip Code [redacted] Cols 66-70
Telephone [redacted] Cols 71-77

Col 80 1

3 How many persons reside in your household? 6 Col 5 6

4 For each person in your household, including yourself, please indicate the age and sex beginning with the oldest and proceeding to the youngest.

	Cols 6-7	Cols 8-9	Cols 10-11	Cols 12-13	Cols 14-15	Cols 16-17	Cols 18-19	Cols 20-21	Cols 22-23	Cols 6-23
Person	1	2	3	4	5	6	7	8	9	
Age	39	30	13	11	12	09				
	Col 24	Col 25	Col 26	Col 27	Col 28	Col 29	Col 30	Col 31	Col 32	Cols 24-32
Sex 1-Male 2-Female	1	2	1	2	1	1				

5 Has any one of your household ever been diagnosed as having any of the following chronic illnesses

(Person in Household)

		1	2	3	4	5	6	7	8	9		
tuberculosis	✓										Cols 40-49	
malignancies	✓										Cols 50-59	
asthma - hay fever		✓	✓	✓	✓	✓	✓				Cols 60-69	
diabetes											Cols 70-79	Col 80
heart conditions	✓										Cols 10-19	2
hypertension	✓										Cols 20-29	
chronic sinusitis & bronchitis		✓	✓								Cols 30-39	
arthritis & rheumatism	✓										Cols 40-49	
rheumatic heart disease											Cols 50-59	
thyroid disease (specify type)											Cols 60-69	
liver disease (specify type)											Cols 70-79	Col 80
kidney disease (specify type)											Cols 10-19	3

6 During the past year, has anyone of your household been diagnosed as having any of the following diseases?

(Person in Household)

		1	2	3	4	5	6	7	8	9		
polio	✓										Cols 20-29	
infectious jaundice											Cols 30-39	
pneumonia											Cols 40-49	
nephritis											Cols 50-59	
skin disease											Cols 60-69	
pleurisy											Cols 70-79	Col 80
spinal meningitis											Cols 10-19	4
influenza											Cols 20-29	
croup											Cols 30-39	
sleeping sickness											Cols 40-49	
anemia											Cols 50-59	
dysentery											Cols 60-69	
empyema											Cols 70-79	Col 80 5

7 Has anyone in your household experienced any of the following symptoms during the past three months

(Person in Household)

		1	2	3	4	5	6	7	8	9		
severe headache not relieved by aspirin	✓										Cols 10-19	
severe dizziness											Cols 20-29	
severe pain in bones and joints with high fever											Cols 30-39	
severe weight loss											Cols 40-49	
severe night sweats											Cols 50-59	
hemorrhagic rash											Cols 60-69	
canker sores around mouth											Cols 70-79	Col 80
yellow eyeballs											Cols 10-19	6
sore throat											Cols 20-29	
cough				✓							Cols 30-39	
cold					✓						Cols 40-49	

(continued)

TABLE A-3 (continued)

	(Person in Household) 1	2	3	4	5	6	7	8	9		
skin rash face										Cols 50-59	
arms & legs										Cols 60-69	Col 80
body										Cols 70-79	7
diarrhea										Cols 10-19	
bloody diarrhea										Cols 20-29	
bloody urine										Cols 30-39	
burning on urination										Cols 40-49	
nausea										Cols 50-59	
vomiting				✓						Cols 60-69	Col 80
pain in chest on deep breathing										Cols 70-79	8
weakness of arms or legs										Cols 10-19	
cough up blood										Cols 20-29	
stiff neck with fever										Cols 30-39	
stiff neck with rash										Cols 40-49	
general weakness										Cols 50-59	
draining ear										Cols 60-69	Col 80
fever above 103°F										Cols 70-79	9
severe trouble with teeth										Cols 10-19	
colicky pains in abdomen										Cols 20-29	
brown urine										Cols 30-39	
shortness of breath										Cols 40-49	
convulsions										Cols 50-59	
unconsciousness (not due to blow on head)										Cols 60-69	
yellow skin										Cols 70-79	Col 80 +

8. How long have you

	Months 0-2	3-5	6-8	9-11	12-23	24-35	more than 3 years	No Response	
Lived in your present city or town?	1	2	3	4	5	6	[✓ 7]	9	Col 6 7
Lived at your present address?	1	2	3	4	5	6	[✓ 7]	9	Col 8 7

9. How many times have you and your family changed living quarters during the last five years? 1 times

Col 9-10
01

10. Is your home air conditioned?
1—No
2—Yes, window only
[✓ 3]—Yes, central

Col 12
3

11. How many bedrooms do you have in your home? 4 bedrooms

Col 13
4

12. What is the usual occupation of the head of your household?

Occupation	Code	Occupation	Code	Occupation	Code
Professional	01	Foreman/Craftsman	06	Teacher	11
Administrative	02	Laborer (kitchen, custodial, maintenance)	07	Librarian	12
Technical	03	Student	08	Housewife	13
Clerical (sec'y, file clerk, cashier)	04	Volunteer Worker	09	Public assistance (policeman, fireman)	14
Sales	05	Waiter, waitress	10	Retired	15

Cols 14-15
05

13. What educational level has been completed by the head of your household

1—less than 8th grade
2—8th grade
3—high school—incomplete
4—high school—completed
5—college—incomplete
6—college—completed
7—graduate school

Col 16
6

14. Distance from John Egan Treatment Plant (refer to map for coding A-K)

Col 20
7

15. Sector

Cols 22-23
18

16. Distance to nearest

	less than 2 blocks	less than 1 mile	one mile or more
a. freeway, expressway or turnpike	1	2	3
b. other major multilane traffic artery	1	2	3
c. large industrial operation	1	2	3

Cols 24-26
313

17. IMNOWO 1 2 3 4 [✓ 5] 6

Col 27
5

Col 80
-

TABLE A-4 HEALTH SURVEY PARTICIPANT QUESTIONNAIRE

Form Approved
OMB No. 158 R0117

STAFF USE ONLY
Cols 1-4
ID # 0 6 5 2

HEALTH SURVEY PARTICIPANT QUESTIONNAIRE

1. Name (in full) [redacted]
2. Address Street [redacted]
City [redacted]
Zip Code [redacted]
Telephone [redacted]
3. Date of Birth 10 Month 19 Day 50 Year
4. What is your sex? 1-male [✓ 2-female]
5. What is your marital status? [✓ 1-single] 2-married 3-separated 4-divorced 5-widowed
6. Which of these best describes *your* present occupational status:
[✓ 1-employed fulltime (including self-employed)]
2-employed part-time
3-unemployed
4-housewife
5-student
6-play/nursery school
7-pre-school
8-retired
7. What is your usual occupation? (please specify) Consultant – CPA.
8. If you are employed, what is the nature of the company for which you work? (please specify) ____
9. How many hours of the day do you normally spend more than 2 miles from your home? 10 hours
10. What is the natural color of your hair? 1-brown 2-black 3-red [✓ 4-blond] 5-gray
11. Have you ever smoked as many as five packs of cigarettes, that is, as many as 100 cigarettes during your entire life? 1-yes [✓ 2-no]
12. Do you now smoke cigarettes? 1-yes [✓ 2-no]
13. How many years have you lived in your present city or town? 6 mo. years
At your present address? 6 mo. years
14. How many times have you changed living quarters during the last five years? 5 times
15. Do you plan to move during the coming year? 1-yes [✓ 2-no]
16. Have you ever been diagnosed as having any of the following chronic illnesses:

	No	Yes	Presently receiving medication (please specify type)
Tuberculosis	✓		
Malignancies	✓		
Asthma-Hay Fever	✓		

(continued)

Cols 5-30	
Cols 31-50	
Cols 51-65	
Cols 66-70	
Cols 71-77	
Col 80	1
Cols 5-10	1 0 1 1 [illegible]
Col 11	2
Col 12	1
Col 13	1
Cols 14-15	1
Cols 16-17	5
Cols 18-19	1 0
Col 20	4
Col 21	2
Col 22	2
Cols 23-26	1 1
Cols 27-28	5
Col 29	2
Cols 30-32	2
Cols 33-35	2
Cols 36-38	2

TABLE A-4 (continued)

	No	Yes	Presently receiving medication (please specify type)		
Diabetes	✓			2	Cols 39-41
Heart Conditions	✓			2	Cols 42-44
Hypertension	✓			2	Cols 45-47
Chronic Sinusitis & Bronchitis	✓			2	Cols 48-50
Arthritis & Rheumatism		✓		1	Cols 51-53
Rheumatic Heart Disease	✓			2	Cols 54-56
Thyroid Disease (specify type)	✓			2	Cols 57-59
Liver Disease (specify type)	✓			2	Cols 60-62
Kidney Disease (specify type)	✓			2	Cols 63-65

17. Is your home air conditioned? [✓ 1-no] 2-yes, window only 3-yes, central — 1 — Col 66

18. What is the usual occupation of the *head* of your household? (please specify) Same — 1 — Cols 67-68

19. What educational level has been completed by the head of your household: — 7 — Col 69

1-less than 8th grade
2-8th grade
3-high school-incompleted
4-high school-completed
5-college-incomplete
6-college completed
[✓ 7-graduate school]

YOU HAVE COMPLETED THE QUESTIONNAIRE
THANK YOU FOR YOUR COOPERATION

INTERVIEWER NOTE AND RECORD

20. Distance 1/8 mi. — 1 — Col 70

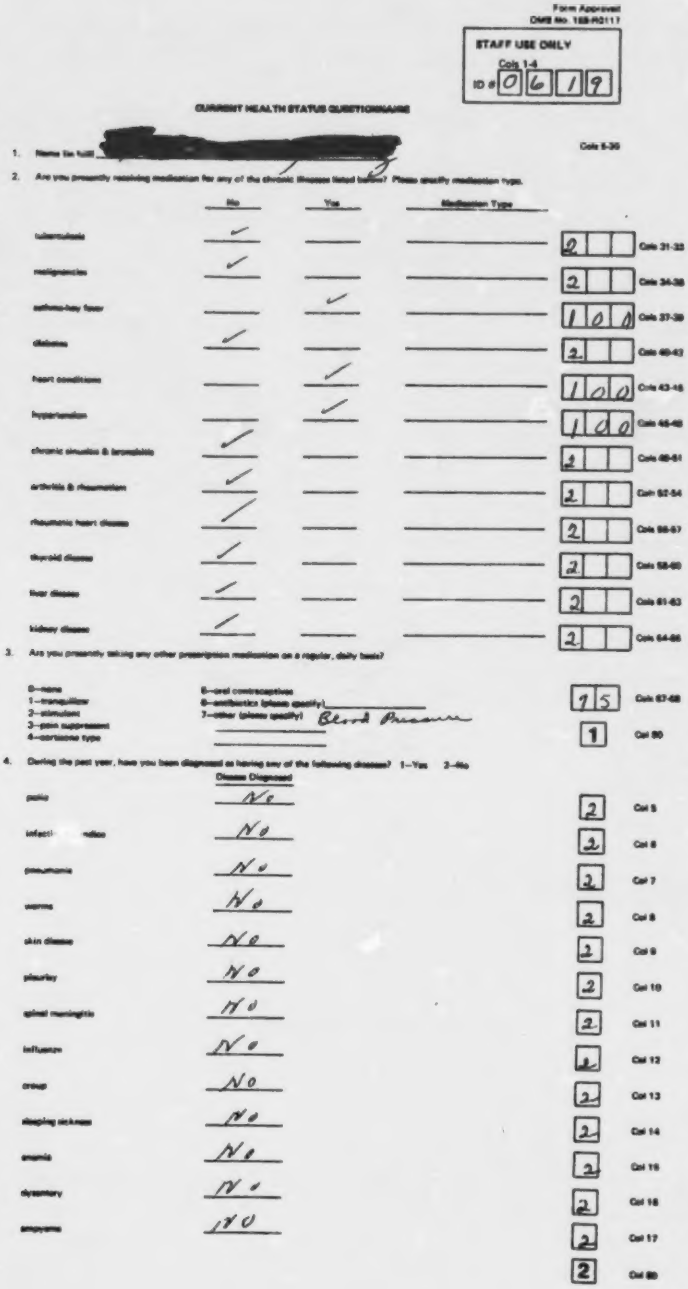
21. Sector — 1 — Col 71

22. Distance to nearest:

	less than 2 blocks	less than 1 mile	one mile or more		
a. freeway, expressway or turnpike	1	2	[✓ 3]	3	Col 72
b. other major multilane traffic artery	1	2	[✓ 3]	3	Col 73
c. large industrial operation	1	2	[✓ 3]	3	Col 74

23. IMNOWO 1 2 3 4 [✓ 5] 6 — 5 — 2 — Col 80

TABLE A-5 CURRENT HEALTH STATUS QUESTIONNAIRE



Form Approved
OMB No. 155-R0117

STAFF USE ONLY
Cols 1-4
ID # 0 6 1 9

CURRENT HEALTH STATUS QUESTIONNAIRE

1. Name (in full) [redacted] Cols 5-30

2. Are you presently receiving medication for any of the chronic illnesses listed below? Please specify medication type.

	No	Yes	Medication Type		
tuberculosis	✓			2	Cols 31-33
malignancies	✓			2	Cols 34-36
asthma-hay fever		✓		1 0 0	Cols 37-39
diabetes	✓			2	Cols 40-42
heart conditions		✓		1 0 0	Cols 43-45
hypertension		✓		1 0 0	Cols 46-48
chronic sinusitis & bronchitis	✓			2	Cols 49-51
arthritis & rheumatism	✓			2	Cols 52-54
rheumatic heart disease	✓			2	Cols 55-57
thyroid disease	✓			2	Cols 58-60
liver disease	✓			2	Cols 61-63
kidney disease	✓			2	Cols 64-66

3. Are you presently taking any other prescription medication on a regular, daily basis?

0—none	5—oral contraceptives	7 5	Cols 67-68
1—tranquilizer	6—antibiotics (please specify)		
2—stimulant	7—other (please specify) Blood Pressure		
3—pain suppressant		1	Col 80
4—cortisone type			

4. During the past year, have you been diagnosed as having any of the following diseases? 1—Yes 2—No

	Disease Diagnosed		
polio	No	2	Col 5
infecti ndice	No	2	Col 6
pneumonia	No	2	Col 7
worms	No	2	Col 8
skin disease	No	2	Col 9
pleurisy	No	2	Col 10
spinal meningitis	No	2	Col 11
influenza	No	2	Col 12
croup	No	2	Col 13
sleeping sickness	No	2	Col 14
anemia	No	2	Col 15
dysentery	No	2	Col 16
empyema	NO	2	Col 17
		2	Col 80

(continued)

TABLE A-5 (continued)

5. Have you experienced any of the following symptoms during: the past three months? At present?

	Experienced during past three months		Experiencing at present			
	Yes	No	Yes	No		
severe headache not relieved by aspirin	✓			✓	1 2	Cols 5-6
severe dizziness		✓		✓	2 2	Cols 7-8
severe pain in bones and joints with high fever		✓		✓	2 2	Cols 9-10
severe weight loss		✓		✓	2 2	Cols 11-12
severe night sweats		✓		✓	2 2	Cols 13-14
hemorrhagic rash		✓		✓	2 2	Cols 15-16
canker sores around mouth		✓		✓	2 2	Cols 17-18
yellow eyeballs		✓		✓	2 2	Cols 19-20
sore throat	✓			✓	1 2	Cols 21-22
cough		✓		✓	2 2	Cols 23-24
cold	✓			✓	1 2	Cols 25-26
skin rash face		✓		✓	2 2	Cols 27-28
arms & legs		✓		✓	2 2	Cols 29-30
body		✓		✓	2 2	Cols 31-32
diarrhea		✓		✓	2 2	Cols 33-34
bloody diarrhea		✓		✓	2 2	Cols 35-36
bloody urine		✓		✓	2 2	Cols 37-38
burning on urination		✓		✓	2 2	Cols 39-40
nausea		✓		✓	2 2	Cols 41-42
vomiting		✓		✓	2 2	Cols 43-44
yellow skin		✓		✓	2 2	Cols 45-46
pain in chest on deep breathing		✓		✓	2 2	Cols 47-48
weakness of arms or legs		✓		✓	2 2	Cols 49-50
cough up blood		✓		✓	2 2	Cols 51-52
stiff neck with fever		✓		✓	2 2	Cols 53-54
stiff neck with rash		✓		✓	2 2	Cols 55-56
general weakness		✓		✓	2 2	Cols 57-58
draining ear		✓		✓	2 2	Cols 59-60
fever above 103°F		✓		✓	2 2	Cols 61-62
severe trouble with teeth	✓			✓	1 2	Cols 63-64
colicky pains in abdomen		✓		✓	2 2	Cols 65-66
brown urine		✓		✓	2 2	Cols 67-68
shortness of breath		✓		✓	2 2	Cols 69-70
convulsions		✓		✓	2 2	Cols 71-72
unconsciousness (not due to blow on head)		✓		✓	2 2	Cols 73-74

Period

[illegible] Col. 78

3 Col 80

YOU HAVE COMPLETED THE QUESTIONNAIRE – THANK YOU FOR YOUR COOPERATION

TABLE A-6 METAL ANALYSIS CODING FORM

Chicago 5 Hair ($\mu g/gm$)

1 HAIR Sample values corrected to 100% Recovery.

Detection Limit
Cd 0.13 $\mu g/gm$
Pb 0.87 "
Hg 0.17 "

Standard Range
Cd 0.5 - 1.5 $\mu g/gm$
Pb 5.0 - 30 $\mu g/gm$
Hg 0.5 - 2.0 $\mu g/gm$

METAL ANALYSIS CODING FORM

Units:		ml	100ml	liter	gm	m^3
10^{-3}	mg	A	E	I	M	Q
10^{-6}	μg	B	F	J	N	R
10^{-9}	ng	C	G	K	O	S
10^{-12}	pg	D	H	L	P	T

Symbols:	
CD Cadmium	PB Lead
CU Copper	PD Palladium
HC Hematocrits	PT Platinum
HG Mercury	SG Specific Gravity
	ZN Zinc

Form:
H Human Subject
S Site Sample

	ID Number	Sample medium	Sample analysis	Site Code	Sampling period	Subper/Sample #	Sub-subperiod	Project Number	Sample Medium (Blood, feces, air, soil, liver, etc.)	Standard Unit	Analysis 1 Symbol	Analysis 1 Value	Analysis 1 Unit	Analysis 2 Symbol	Analysis 2 Value	Analysis 2 Unit	Analysis 3 Symbol	Analysis 3 Value	Analysis 3 Unit	Analysis 4 Symbol	Analysis 4 Value	Analysis 4 Unit	Analysis 5 Symbol	Analysis 5 Value	Analysis 5 Unit	Analysis 6 Symbol	Analysis 6 Value	Analysis 6 Unit		Form H/S	Card No.
F	0001	H	H	CH	5	1		4007	HAIR	N	CD	0.91	N	PB	13.15	N	CU		N	ZN		N	HG	0.82					M	H	1
F	02											<0.13			1.68									0.27					M		
M	03											0.31			11.44									I.S.					M		
M	04											1.06			29.12									I.S.					M		
M	05											0.53			17.41									I.S.					M		
M	06											1.43			17.63									0.64					M		
F	09											0.25			6.81									I.S.					M		
F	10											0.52			7.41									I.S.					M		
F	11											<0.13			9.42									I.S.					M		
M	12											<0.13			9.54									I.S.					M		
F	13											0.25			48.67									I.S.					M		
M	14											0.43			4.81									I.S.					M		
F	15											0.13			4.95									I.S.					M		
F	16											1.83			25.75									I.S.					M		
M	18											1.03			29.07									0.33					M		
F	19											0.17			6.46									I.S.					M		
	21																												M		
F	29											0.32			6.18									I.S.					M		
M	30											0.59			<0.87									0.21					M		
M	31											0.51			4.29									<0.17					M		
M	32											0.36			7.65									I.S.					M		
	0033	H	H	CH	5	1		4007	HAIR	N	CD		N	PB		N	CU		N	ZN		N	HG						M	H	1

TABLE A-7 PATHOGEN ANALYSIS CODING FORM

Master Codes:
0, bl. Not tested
1 None found
2 Presence identified
3 Present and counted

General Pathogen Codes:

Type	Gen. Codes	Unit
Bacteria	100s	0
Parasite	300s to 500s	0
Virus	700s, 800s	0
Antibody	700s, 800s	2-5

Antibody Test Codes
Unit Digit-Test
2-Complement-Fix.
3-Serium Neutvaliz.
4-Hemagglut. Inhib.
5-Fluorescent Antib.

Form:
H Human Subject
S Site Sample

Label Code: ID Number	Label Code: Sample medium	Label Code: Sample analysis	Label Code: Site Code	Label Code: Sampling period	Label Code: Subper./Sample #	Label Code: Sub-subperiod	Label Code: Project Number	Specimen (Sample Medium) (Blood, feces, throatswab, sputum, air, soil, water sewage, etc.)	Master Codes: Bacteria	Master Codes: Parasites	Master Codes: Viruses	Master Codes: Antibodies	Codes of Pathogens Found in Sample: 1 1	2 #	3 2	4 #	5 3	6 #	7 4	8 #	9 5	10 #	11 6	12 #	13 7	14 #	15 8	16 #	Pathogen	Form H/S	Card Identifier
1	T	B	CH	4	1		4007	THROATSWAB	2				170	190															P	H	1
																													P		
2									1																				P		
																													P		
3									2				170																P		
																													P		
4									1																				P		
																													P		
5									1																				P		
																													P		
6									1																				P		
																													P		
9									2				170																P		
																													P		
10									2				190																P		
																													P		
11									2				170	190															P		
																													P		
12									2				170	190															P		
																													P		
13									2				170																P		
																													P		

TABLE A-8 PATHOGEN ANALYSIS DATA FORM

01-4007 PATHOGEN ANALYSIS

P - POSITIVE
N - NEGATIVE

Tissue: Feces **SwRI Code** FBCH 112 4007

Analysis: Bacterial **Specific** Proteus **Code** 110

0 - 22 0 21
- 5 - 1
+ 1 + 0

Participant ID #	Period # 1 Oct. '74	Period #5 Oct. '76	Change +/-	Period #2 Feb. '75	Period #4 Feb. '76	Change +/-
1	~~N~~ N	N	0	N	N	0
2	N	N	0	—	N	
3	N	N		—	P	
4	N	N		N	N	0
5	N	—		N	N	0
6	N	N	0	—	N	
9	P	N	—	—	N	
10	N	N	0	N	—	
11	N	N	0	N	N	0
12	N	N	0	N	N	
13	N	N	0	N	N	0
14	N	N	0	N	N	0
15	N	—		P	N	—
16	N	P	+	N	N	0
18	N	N	0	N	N	0
19	P	N	—	N	N	
29	N	N	0	N	N	
30	N	N		N	N	0
31	N	N		N	N	
32	P	N	-	N	—	
33	N	N		—	N	
49	N	N	0	N	N	
50	—	N		N	N	0
74	P	N	—	N	N	0
75	—	N		N	N	0
76	N	N		—	—	
77	N	N	0	N	N	0
78	N	N	.	—	N	
83	P	N	—	N	N	0
84	N	N	0	N	N	0
97	N	N	0	N	N	0
98	N	N	0	N	N	0

(continued)

TABLE A-8 (continued)

01-4007 PATHOGEN ANALYSIS

P - POSITIVE
N - NEGATIVE

Tissue: Feces SwRI Code FBCH43 4007

Analysis: Bacterial Specific Proteus Code 110

0- 14
– 2
+ 2
1 2

0 14
– 5
+ 3
1 2

Participant ID #	Period # 1 Oct. '74	Period #5 Oct. '76	Change +/-	Period #2 Feb. '75	Period #4 Feb. '76	Change +/-
99	N	N	0	N	N	0
100	N	N	0	N	N	0
101	N	N	0	N	N	0
102	N	N	0	N	N	0
103	N	N	0	N	N	0
113	N			N		
114	N			N		
115	N			N		
116	P			–		
117	N			–		
131	N	N	0	N	N	0
141	P	P	1	N	–	
142	N	N	0	N	P	+
143	N	N	0	N	P	+
144	P	–		N	N	0
145	N	N	0	N	N	0
146	N	N		N	N	0
157	N	N		P	N	–
158	N	N		N	N	0
159	N	N		N	–	
160	N	P	+	–	–	
162	N	N	0	P	N	–
165	N	N	0	N	N	0
166	N	N	0	N	N	0
167	N			P		
171	P	P	1	P	N	–
172	P	N	–	P	N	–
177	N	N	0	N	P	+
178	N	P	+	N	–	
179	P	N	–	N	N	0
180	N	N	0	P	N	–
181	N	N	0	N	N	0

APPENDIX H

INDIVIDUAL PARTICIPANT DATA TABLES

Table	Title
A-9	BACTERIAL ISOLATIONS IN FECES SAMPLES FROM INDIVIDUAL PARTICIPANTS
A-10	BACTERIAL ISOLATIONS IN THROAT SWABS FROM INDIVIDUAL PARTICIPANTS
A-11	PARASITE ISOLATIONS IN FECES SAMPLES FROM INDIVIDUAL PARTICIPANTS
A-12	VIRAL ISOLATIONS IN FECES SAMPLES AND THROAT SWABS FROM INDIVIDUAL PARTICIPANTS
A-13	COXSACKIEVIRUS AND POLIOVIRUS ANTIBODY TITERS FROM ALL INDIVIDUAL PARTICIPANTS
A-14	ECHOVIRUS ANTIBODY TITERS BY HEMAGGLUTINATION INHIBITION FROM ALL INDIVIDUAL PARTICIPANTS
A-15	ADENOVIRUS ANTIBODY TITERS BY SERUM NEUTRALIZATION FROM 100 INDIVIDUAL PARTICIPANTS
A-16	COXSACKIEVIRUS ANTIBODY TITERS FROM 100 INDIVIDUAL PARTICIPANTS
A-17	ECHOVIRUS ANTIBODY TITERS BY SERUM NEUTRALIZATION FROM 100 INDIVIDUAL PARTICIPANTS
A-18	ECHOVIRUS ANTIBODY TITERS BY HEMAGGLUTINATION INHIBITION FROM 100 INDIVIDUAL PARTICIPANTS
A-19	REOVIRUS ANTIBODY TITERS BY HEMAGGLUTINATION INHIBITION FROM 100 INDIVIDUAL PARTICIPANTS
A-20	TRACE METAL CONCENTRATIONS IN BLOOD SAMPLES FROM INDIVIDUAL PARTICIPANTS (μg/100 ml)
A-21	TRACE METAL CONCENTRATIONS IN FECES SAMPLES FROM INDIVIDUAL PARTICIPANTS (μg/g)
A-22	TRACE METAL CONCENTRATIONS IN HAIR SAMPLES FROM INDIVIDUAL PARTICIPANTS (μg/g)
A-23	TRACE METAL CONCENTRATIONS IN URINE SAMPLES FROM INDIVIDUAL PARTICIPANTS (μg/l)
A-24	HEMATOCRIT VALUE OF BLOOD SAMPLES FROM INDIVIDUAL PARTICIPANTS

SYMBOLS USED IN REPORTING INDIVIDUAL PARTICIPANT DATA:

P	Positive
N	Negative
NSC	No sample was collected
IS	Insufficient sample for analysis
NA	Sample was not analyzed
U	Unsatisfactory because nonspecific inhibitors were not removed by kaolinizing and absorbing with human type "O" erythrocytes

TABLE A-9 BACTERIAL ISOLATIONS IN FECES SAMPLES FROM INDIVIDUAL PARTICIPANTS

Participant I.D.	Proteus				Pseudomonas				Salmonella				Enterobacter			
	Period				Period				Period				Period			
	1	2	4	5	1	2	4	5	1	2	4	5	1	2	4	5
1	N	N	N	N	N	N	N	N	N	N	N	N	P	P	P	P
2	N	NSC	N	N	N	NSC	N	N	N	NSC	N	N	P	NSC	P	N
3	N	NSC	P	N	N	NSC	N	N	N	NSC	N	N	N	NSC	P	P
4	N	N	N	N	N	N	N	N	N	N	N	N	P	P	P	P
5	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	P	N	P	NSC
6	N	NSC	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	P	N
9	P	NSC	N	N	N	NSC	N	P	N	NSC	N	N	N	NSC	P	N
10	N	N	NSC	N	N	N	N	N	N	N	N	N	N	N	NSC	N
11	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
12	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	N
13	N	N	N	N	N	N	N	N	N	N	N	N	P	N	P	P
14	N	N	N	N	N	N	N	N	N	N	N	N	P	P	N	N
15	N	P	N	NSC	N	N	N	NSC	N	N	N	NSC	P	N	P	NSC
16	N	N	N	P	N	N	N	N	N	N	N	N	N	P	N	P
18	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	N
19	P	N	N	N	N	N	N	N	N	N	N	N	P	P	N	N
29	N	N	N	N	N	N	N	N	N	N	N	N	P	N	P	N
30	N	N	N	N	N	N	N	N	N	N	N	N	N	P	P	N
31	N	N	N	N	P	N	N	N	N	N	N	N	P	N	N	P
32	P	N	NSC	N	P	N	N	N	N	N	N	N	N	N	P	P
33	N	NSC	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	P	P
49	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
50	NSC	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	P	N	N
74	P	N	N	N	N	N	N	N	N	N	N	N	N	P	P	P
75	NSC	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	N	N	P
76	N	NSC	NSC	N	N	NSC	N	N	N	NSC	N	N	P	NSC	P	P
77	N	N	N	N	N	N	N	N	N	N	N	N	P	N	P	P
78	N	NSC	N	N	N	NSC	N	N	N	NSC	N	N	P	NSC	P	P
83	P	N	N	N	N	N	N	N	N	N	N	N	P	N	P	N
84	N	N	N	N	N	N	N	N	N	N	N	N	P	P	P	P
97	N	N	N	N	N	N	N	N	N	N	N	N	P	N	N	P
98	N	N	N	N	N	N	N	N	N	N	N	N	P	N	P	N
99	N	N	N	N	N	N	N	N	N	N	N	N	P	N	P	P
100	N	N	N	N	N	N	N	N	N	N	N	N	P	N	P	P
101	N	N	N	N	N	N	N	N	N	N	N	N	P	N	N	P
102	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
103	N	N	N	N	N	N	N	N	N	N	N	N	P	N	N	P
113	N	N	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC	P	N	NSC	NSC
114	N	N	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC	P	N	NSC	NSC
115	N	N	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC	N	P	NSC	NSC
116	N	NSC	NSC	NSC	N	NSC	NSC	NSC	N	NSC	NSC	NSC	N	NSC	NSC	NSC
117	N	NSC	NSC	NSC	N	NSC	NSC	NSC	N	NSC	NSC	NSC	N	NSC	NSC	NSC
131	N	N	N	N	N	N	N	N	N	N	N	N	P	P	N	P
141	P	N	NSC	P	N	P	N	N	N	N	N	N	N	N	NSC	N
142	N	N	P	N	N	N	N	N	N	N	N	N	P	N	P	N
143	N	N	P	N	P	N	N	N	N	N	N	N	N	P	P	P
144	P	N	N	NSC	N	P	N	NSC	N	N	N	NSC	N	P	N	NSC

(continued)

TABLE A-9 (continued)

Participant I.D.	Proteus				Pseudomonas				Salmonella				Enterobacter			
	Period				Period				Period				Period			
	1	2	4	5	1	2	4	5	1	2	4	5	1	2	4	5
145	N	N	N	N	N	N	N	N	N	N	N	N	P	N	N	P
146	N	N	N	N	N	N	N	N	N	N	N	N	P	P	P	P
157	N	P	N	N	N	N	N	N	N	N	N	N	N	P	N	P
158	N	N	N	N	N	N	N	N	N	N	N	N	P	N	P	P
159	N	N	NSC	N	N	N	N	N	N	N	N	N	P	P	NSC	N
160	N	NSC	NSC	P	N	NSC	N	N	N	NSC	N	N	P	NSC	NSC	N
162	N	P	N	N	N	N	N	N	N	N	N	N	N	N	N	N
165	N	N	N	N	N	P	N	N	N	N	N	N	P	P	N	N
166	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	N
167	N	P	NSC	NSC	N	NSC	NSC	NSC	N	N	NSC	NSC	P	P	NSC	NSC
171	P	P	N	P	N	N	N	N	N	N	N	N	P	P	P	P
172	P	P	N	N	N	N	N	N	N	N	N	N	P	P	N	P
177	N	N	P	N	N	N	N	N	N	N	N	N	P	P	P	N
178	N	N	NSC	P	N	N	P	N	N	N	N	N	P	N	N	P
179	P	N	N	N	N	P	N	N	N	N	N	N	N	N	N	N
180	N	P	N	N	N	N	N	N	N	N	N	N	P	P	P	N
181	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	P
182	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	N
183	N	N	N	N	N	N	N	N	N	N	N	N	P	P	N	N
189	N	N	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC	P	P	NSC	NSC
190	NSC	N	NSC	NSC	NSC	N	NSC	NSC	NSC	N	NSC	NSC	NSC	N	NSC	NSC
191	N	N	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC	P	N	NSC	NSC
192	P	N	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC	N	P	NSC	NSC
193	P	N	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC
194	N	N	NSC	NSC	P	N	NSC	NSC	N	N	NSC	NSC	N	P	NSC	NSC
195	N	N	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC	P	P	NSC	NSC
196	N	N	N	N	N	N	N	N	N	N	N	N	P	P	N	N
198	N	N	N	N	N	N	N	N	N	N	N	N	P	N	P	N
199	N	NSC	N	N	N	NSC	N	N	N	NSC	N	N	P	NSC	P	P
201	N	N	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC	P	N	NSC	NSC
202	N	N	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC	P	N	NSC	NSC
206	P	P	N	N	N	N	N	N	N	N	N	N	P	P	N	N
207	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P
208	N	P	N	N	N	N	N	N	N	N	N	N	N	N	P	P
209	N	N	N	N	N	N	N	N	N	N	N	P	P	N	N	P
213	N	N	N	N	N	P	N	N	N	N	N	N	P	N	N	P
214	N	N	P	P	N	N	N	N	N	N	N	N	N	P	P	N
226	N	P	NSC	P	N	N	N	N	N	N	N	N	N	P	NSC	P
227	N	N	NSC	N	N	N	N	P	N	N	N	N	P	P	NSC	N
228	N	N	N	N	N	N	N	N	N	N	N	N	P	N	N	N
229	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
230	N	N	N	N	N	N	N	N	N	N	N	N	P	P	P	P
231	N	N	N	N	N	N	N	N	N	N	N	N	P	N	N	N
232	N	P	N	P	N	N	N	N	N	N	N	N	P	N	N	N
233	NSC	P	N	N	NSC	N	N	N	NSC	N	N	N	NSC	N	P	N
235	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	P
241	N	N	N	N	N	N	N	N	N	N	N	N	P	N	P	N

(continued)

TABLE A-9 (continued)

Participant I.D.	Proteus				Pseudomonas				Salmonella				Enterobacter			
	Period				Period				Period				Period			
	1	2	4	5	1	2	4	5	1	2	4	5	1	2	4	5
242	N	P	P	N	N	N	N	N	N	N	N	N	P	P	N	P
243	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC
244	N	NSC	N	N	N	NSC	N	N	N	NSC	N	N	P	NSC	P	N
254	N	P	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC
255	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	N	N	P	NSC
256	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	P	N	P	NSC
257	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	P	N	N	NSC
258	N	N	NSC	NSC	N	N	N	NSC	N	N	N	NSC	P	N	NSC	NSC
260	N	N	N	N	N	N	N	N	N	N	N	N	P	P	P	P
262	P	N	N	N	N	N	N	N	N	N	N	N	N	P	N	N
263	N	N	N	N	N	N	N	P	N	N	N	N	P	N	N	P
266	N	N	N	P	N	N	N	N	N	N	N	N	P	N	N	P
267	N	N	N	N	N	N	N	N	N	N	N	N	P	N	N	N
268	N	N	NSC	N	N	N	N	N	N	N	N	N	P	N	P	P
273	NSC	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	N	P	N
275	N	P	N	N	N	N	N	N	N	N	N	N	N	N	N	N
276	N	N	NSC	N	N	N	P	N	N	N	N	P	P	N	N	N
278	N	P	P	N	N	N	N	N	N	N	N	N	P	N.	P	P
284	N	N	N	N	N	N	N	N	N	N	N	N	P	N	P	P
290	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P
293	N	N	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC
294	N	NSC	NSC	N	N	NSC	N	N	N	NSC	N	N	P	NSC	NSC	N
302	N	N	N	N	N	N	N	N	N	N	N	N	P	P	P	N
303	N	N	N	N	N	N	N	N	N	N	N	N	N	P	P	P
312	N	N	N	N	N	N	N	N	N	N	N	N	P	P	N	N
313	N	N	N	N	N	N	N	N	N	N	N	N	P	N	P	N
314	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	N	P	N	NSC
315	N	N	N	N	N	N	N	N	N	N	N	N	P	P	P	N
316	N	P	N	N	N	N	N	N	N	N	N	N	P	P	P	P
324	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	P
325	N	P	N	N	N	N	N	N	N	N	N	N	N	P	N	N
330	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	N
334	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	N
335	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
336	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P
337	N	N	N	N	N	P	N	N	N	N	N	P	N	P	P	N
338	N	NSC	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	N	N
339	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P
340	P	N	N	N	P	N	N	N	N	N	N	N	P	N	N	N
341	N	N	NSC	N	N	N	N	N	N	N	N	N	N	N	NSC	P
342	N	N	NSC	N	N	N	N	N	N	N	N	N	P	N	NSC	P
343	N	N	N	N	N	N	N	N	N	N	N	N	N	P	N	P
348	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	P
349	N	N	N	N	P	N	N	N	N	N	N	N	P	N	N	N
350	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
353	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	P	N	N	NSC
354	N	N	N	N	P	P	N	N	N	N	N	N	N	N	P	N

(continued)

TABLE A-9 (continued)

Participant I.D.	Proteus				Pseudomonas				Salmonella				Enterobacter			
	Period				Period				Period				Period			
	1	2	4	5	1	2	4	5	1	2	4	5	1	2	4	5
355	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	N
356	N	N	N	N	N	N	N	N	N	N	N	N	P	N	N	N
359	N	N	N	N	N	N	N	N	N	N	N	N	P	P	P	P
361	P	N	N	P	N	N	N	N	N	N	N	N	N	P	P	N
362	N	N	N	N	N	N	N	N	N	N	N	N	P	N	N	N
363	N	N	NSC	NSC	N	N	N	NSC	N	N	N	NSC	N	N	NSC	NSC
364	P	N	N	N	N	N	N	N	N	N	N	N	P	P	P	N
365	N	N	N	N	N	N	N	N	N	N	N	N	P	P	N	N
366	N	N	N	N	N	N	N	N	N	N	N	P	P	N	N	P
367	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	N
368	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
370	N	N	N	P	N	N	N	N	N	N	N	N	P	P	N	N
372	N	N	N	P	N	N	N	P	N	N	N	N	P	N	N	N
373	N	NSC	N	N	N	NSC	N	N	N	NSC	N	N	P	NSC	P	N
374	N	N	N	P	N	N	N	N	N	N	N	N	P	N	N	P
375	N	N	N	N	N	P	N	N	N	N	N	N	P	N	P	N
378	N	P	NSC	N	N	N	N	N	N	N	N	N	P	N	NSC	N
383	N	P	NSC	NSC	N	NSC	NSC	NSC	N	NSC	NSC	NSC	P	N	NSC	NSC
384	N	P	NSC	NSC	N	NSC	NSC	NSC	N	NSC	NSC	NSC	P	N	NSC	NSC
385	N	P	N	N	N	N	N	N	N	N	N	N	P	N	N	P
386	N	NSC	N	N	N	NSC	N	N	N	NSC	N	N	P	NSC	N	N
387	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	P	N	P	NSC
388	NSC	N	N	P	NSC	N	N	N	NSC	N	N	N	NSC	N	N	P
390	NSC	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	P	P	N
391	N	N	N	N	N	P	N	P	N	N	N	N	P	N	N	P
392	N	NSC	N	N	N	NSC	N	N	N	NSC	N	N	P	NSC	N	P
393	N	N	N	N	N	N	N	N	N	N	N	N	P	N	N	N
394	N	NSC	N	NSC	N	NSC	N	NSC	N	NSC	N	NSC	N	NSC	N	NSC
395	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	N	N	P	NSC
396	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	P	P	P	NSC
397	N	P	N	NSC	N	N	N	NSC	N	N	N	NSC	P	P	P	NSC
398	NSC	N	N	N	NSC	N	N	N	NSC	N	N	N	P	N	N	N
399	N	N	N	N	N	N	N	N	N	N	N	N	P	P	N	P
400	N	N	N	P	N	N	N	N	N	N	N	N	P	P	P	N
402	N	NSC	NSC	NSC	N	NSC	NSC	NSC	N	NSC	NSC	NSC	P	NSC	NSC	NSC
403	P	N	N	N	N	N	N	N	N	N	N	N	N	P	P	N
405	N	N	N	N	N	N	N	N	N	N	N	N	P	P	P	N
406	N	NSC	N	N	N	NSC	N	P	N	NSC	N	N	P	NSC	P	N
407	N	N	NSC	N	N	N	N	P	N	N	N	N	P	N	NSC	N
408	N	N	N	N	N	N	N	N	N	N	N	N	P	P	P	N
412	N	N	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC	P	N	NSC	NSC
413	NSC	N	NSC	NSC	NSC	N	NSC	NSC	NSC	N	NSC	NSC	NSC	N	NSC	NSC
414	N	P	N	N	N	N	N	N	N	N	N	N	P	P	N	N
415	N	P	N	NSC	N	N	N	NSC	N	N	N	NSC	P	P	N	NSC
416	N	P	N	N	N	N	N	N	N	N	N	N	N	P	N	N
417	N	P	N	NSC	N	N	N	NSC	N	N	N	NSC	P	P	N	NSC
418	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC

(continued)

TABLE A-9 (continued)

Participant I.D.	Proteus Period 1	Proteus Period 2	Proteus Period 4	Proteus Period 5	Pseudomonas Period 1	Pseudomonas Period 2	Pseudomonas Period 4	Pseudomonas Period 5	Salmonella Period 1	Salmonella Period 2	Salmonella Period 4	Salmonella Period 5	Enterobacter Period 1	Enterobacter Period 2	Enterobacter Period 4	Enterobacter Period 5
419	P	N	N	P	P	N	N	N	N	N	N	N	N	N	P	N
421	P	P	N	N	P	N	N	N	N	N	N	N	N	P	P	N
422	P	N	N	N	N	N	N	N	N	N	N	N	N	P	P	P
423	NSC	N	N	P	NSC	N	N	N	NSC	N	N	N	NSC	N	P	P
424	N	P	N	N	N	N	N	N	N	N	N	N	P	N	N	N
426	P	N	N	N	N	N	N	N	N	N	N	N	N	P	N	N
428	N	NSC	N	N	N	NSC	N	N	N	NSC	N	N	P	NSC	N	N
429	N	N	N	N	N	N	N	N	N	N	N	N	N	P	P	N
430	N	N	N	N	N	N	N	N	N	N	N	N	N	P	N	N
438	P	N	NSC	NSC	P	N	NSC	NSC	N	N	NSC	NSC	P	N	NSC	NSC
441	P	N	P	N	N	N	N	N	N	N	N	N	P	P	N	P
442	N	N	N	N	N	N	N	N	N	N	N	N	P	N	P	P
443	N	NSC	N	P	N	NSC	N	N	N	NSC	N	N	N	NSC	P	P
445	N	NSC	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	N	P
446	N	N	N	N	N	N	N	NSC	N	N	N	NSC	P	N	N	NSC
449	N	N	N	N	N	N	N	N	N	N	N	N	P	N	N	P
450	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	P	P	N	NSC
451	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	P	P	N	NSC
452	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	P	N	P	NSC
453	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC
454	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC
455	N	P	N	N	N	N	N	N	N	N	N	N	N	N	N	P
457	N	N	N	N	N	N	N	N	N	N	N	N	P	N	P	N
458	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	N
459	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P
460	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	N
461	P	N	N	NSC	N	N	N	NSC	N	N	N	NSC	P	N	N	NSC
464	N	N	N	N	N	N	N	N	N	N	N	N	P	P	N	N
465	N	N	P	N	N	N	N	N	N	N	N	N	N	N	N	N
466	N	N	NSC	NSC	N	N	N	NSC	N	N	N	NSC	N	P	NSC	NSC
467	N	N	NSC	NSC	N	N	N	NSC	N	N	N	NSC	N	P	NSC	NSC
468	NSC	N	NSC	N	NSC	NSC	N	N	NSC	NSC	NSC	N	NSC	P	N	N
500	NSC	NSC	NSC	NSC	NSC	NSC	N	NSC	NSC	NSC	N	NSC	NSC	NSC	NSC	NSC
501	NSC	N	NSC	NSC	NSC	N	NSC	NSC	NSC	N	NSC	NSC	NSC	N	NSC	NSC
502	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
503	NSC	N	NSC	NSC	NSC	P	NSC	NSC	NSC	N	NSC	NSC	NSC	N	NSC	NSC
504	N	N	N	N	NSC	N	N	N	NSC	N	N	N	N	N	P	P
505	N	NSC	NSC	N	N	NSC	N	N	N	NSC	N	N	N	NSC	N	N
506	N	NSC	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	N	N
507	NSC	P	N	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC	N	N	NSC
508	NSC	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	N	N	N
509	NSC	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	P	P	P
510	NSC	N	N	N	NSC	N	N	N	NSC	N	N	N	NSC	P	N	N
512	NSC	N	NSC	N	NSC	N	N	N	NSC	N	N	N	NSC	P	N	N

(continued)

TABLE A-9 (continued)

Participant I.D.	Proteus Period 3	Proteus Period 5	Pseudomonas Period 3	Pseudomonas Period 5	Salmonella Period 3	Salmonella Period 5	Enterobacter Period 3	Enterobacter Period 5
600	N	N	N	N	N	N	N	N
601	N	N	N	N	P	N	N	P
602	N	N	N	N	N	N	P	N
603	N	N	N	N	N	N	P	N
604	N	NSC	N	NSC	N	NSC	N	NSC
605	N	NSC	N	NSC	N	NSC	N	NSC
607	P	NSC	N	NSC	N	NSC	P	NSC
608	N	NSC	N	NSC	N	NSC	P	NSC
609	N	NSC	N	NSC	N	NSC	P	NSC
610	NSC	NSC	N	NSC	N	NSC	NSC	NSC
611	N	NSC	N	NSC	N	NSC	P	NSC
612	N	NSC	N	NSC	N	NSC	P	NSC
613	P	NSC	N	NSC	N	NSC	P	NSC
614	N	N	N	N	N	P	P	N
615	N	N	N	N	N	N	P	N
616	N	N	N	N	N	N	P	N
617	N	N	N	N	N	N	N	N
618	N	N	N	N	N	N	N	N
619	N	N	N	N	N	N	P	N
620	N	NSC	N	NSC	N	NSC	P	NSC
621	N	N	N	N	N	N	P	P
622	N	N	N	N	N	N	N	P
623	N	N	N	N	N	N	N	N
624	P	NSC	N	NSC	N	NSC	NSC	NSC
625	N	NSC	N	NSC	N	NSC	P	NSC
626	P	NSC	N	NSC	N	NSC	P	NSC
628	N	N	N	N	N	N	N	N
629	N	N	N	N	N	N	N	N
630	N	N	N	N	N	N	P	N
631	N	N	N	N	N	N	N	N
632	N	N	N	N	N	N	N	N
633	N	NSC	N	NSC	N	NSC	N	NSC
634	N	N	N	N	N	N	N	N
637	N	NSC	N	NSC	N	NSC	P	NSC
640	NSC	N	NSC	N	NSC	N	NSC	N
641	N	N	N	N	N	N	P	N
642	N	N	N	N	N	N	N	P
643	N	N	N	N	N	N	P	N
644	N	N	N	N	N	N	P	N
645	N	N	N	N	N	N	N	N
646	P	N	P	N	N	N	P	N
647	N	P	N	N	N	N	P	N
648	N	P	N	N	N	N	P	N
649	N	NSC	N	NSC	N	NSC	N	NSC
650	N	N	N	N	N	N	N	N
651	N	N	N	N	N	P	P	N
652	N	N	N	N	N	N	P	P
653	NSC	N	NSC	N	NSC	N	NSC	P
654	NSC	N	NSC	N	NSC	N	NSC	N

TABLE A-10 BACTERIAL ISOLATIONS IN THROAT SWABS FROM INDIVIDUAL PARTICIPANTS

Participant I.D.	Streptococcus-alpha				Streptococcus-beta				Streptococcus-gamma				Staphylococcus aureus			
	Period				Period				Period				Period			
	1	2	4	5	1	2	4	5	1	2	4	5	1	2	4	5
1	N	N	N	N	P	N	P	P	N	N	N	N	N	P	P	P
2	N	NSC	N	P	P	NSC	N	P	N	NSC	N	N	N	NSC	N	N
3	N	NSC	N	P	P	NSC	P	P	N	NSC	N	N	P	NSC	N	N
4	N	N	N	N	P	N	N	P	N	N	N	N	N	N	N	P
5	N	N	N	P	P	P	N	P	N	N	N	N	N	N	N	N
6	N	N	N	N	P	P	N	P	N	N	N	N	N	N	N	P
9	N	N	N	N	P	P	P	P	N	N	N	N	N	N	N	P
10	N	N	N	N	P	P	N	P	N	N	N	N	P	N	P	P
11	N	N	N	N	P	P	P	P	N	N	N	N	P	N	P	P
12	N	N	N	N	P	P	P	P	N	N	N	P	N	P	P	N
13	N	N	N	N	P	P	P	P	N	N	N	N	P	P	N	N
14	N	N	N	N	P	P	N	P	N	N	N	N	N	N	P	P
15	N	N	N	N	P	P	P	P	N	N	N	N	N	P	N	P
16	N	N	N	N	P	P	P	P	N	N	N	N	N	P	N	P
18	N	N	N	N	P	P	P	P	N	N	N	P	N	N	N	N
19	N	P	N	P	P	P	P	P	N	N	N	N	N	N	N	N
29	N	N	N	N	P	P	P	P	N	N	N	N	P	P	P	P
30	N	N	N	P	P	P	P	P	N	N	N	N	P	P	P	N
31	N	N	N	P	P	P	P	P	N	N	N	N	P	P	P	N
32	N	N	N	N	P	P	P	P	N	N	N	N	P	P	P	P
33	N	P	N	N	P	P	P	P	N	N	N	N	N	N	P	P
49	N	N	N	N	P	P	N	P	N	N	N	N	N	P	P	P
50	NSC	N	N	N	NSC	P	P	P	NSC	N	P	N	NSC	P	N	P
74	N	N	N	N	P	P	N	P	N	N	N	P	N	P	N	N
75	NSC	N	N	N	NSC	P	N	P	NSC	N	N	N	NSC	N	N	P
76	N	N	N	N	P	P	N	P	N	N	N	N	P	N	N	P
77	N	N	N	N	P	P	P	P	N	N	N	N	N	N	P	P
78	N	N	N	P	P	P	P	N	N	N	N	N	P	N	P	N
83	N	N	N	N	P	P	P	P	N	N	N	N	N	P	P	P
84	N	N	N	N	P	P	P	P	N	N	N	N	P	N	P	P
97	N	N	N	N	P	P	P	P	N	N	N	N	N	P	P	P
98	N	N	N	P	P	P	N	P	N	N	N	N	P	P	N	N
99	P	P	P	P	N	N	N	N	N	P	P	N	N	N	N	P
100	P	P	N	P	N	N	N	N	N	P	P	P	N	N	N	N
101	P	P	N	P	N	N	N	N	N	N	P	P	N	N	N	N
102	P	P	P	P	N	N	N	N	N	P	P	P	N	N	N	N
103	P	P	N	P	N	N	N	N	N	N	N	N	N	P	N	P
113	P	P	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC
114	P	P	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC
115	P	P	NSC	NSC	N	N	NSC	NSC	P	P	NSC	NSC	N	N	NSC	NSC
116	P	P	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC
117	P	P	NSC	NSC	N	N	NSC	NSC	N	P	NSC	NSC	N	N	NSC	NSC
131	P	P	P	P	N	N	N	N	P	N	N	N	N	N	P	P
141	P	P	N	P	N	N	N	N	N	P	N	P	N	N	N	N
142	P	P	P	P	N	N	N	N	P	N	N	P	N	N	N	N
143	P	P	P	P	N	N	N	N	N	P	P	P	N	N	N	N
144	P	P	P	P	N	N	N	N	P	N	P	N	N	N	P	P

(continued)

TABLE A-10 (continued)

Participant I.D.	Streptococcus-alpha				Streptococcus-beta				Streptococcus-gamma				Staphylococcus aureus			
	Period				Period				Period				Period			
	1	2	4	5	1	2	4	5	1	2	4	5	1	2	4	5
145	P	P	P	P	N	N	N	P	N	N	N	N	N	N	N	N
146	P	P	P	P	N	N	N	N	P	N	N	N	N	N	N	P
157	P	P	P	P	N	N	N	N	P	N	N	P	N	N	N	N
158	P	P	P	P	N	N	N	N	P	P	P	P	N	N	N	N
159	P	P	P	P	N	N	N	N	N	P	P	P	P	N	N	N
160	P	P	N	P	N	N	N	N	N	P	P	N	N	N	N	P
162	P	P	N	N	N	N	N	N	P	P	P	N	N	P	N	
165	P	P	N	P	N	N	N	N	N	N	N	P	N	N	N	N
166	P	P	N	P	N	N	N	N	P	N	N	P	N	N	N	N
167	P	NSC	NSC	NSC	N	NSC	NSC	NSC	N	NSC	NSC	NSC	N	NSC	NSC	NSC
171	P	N	P	P	N	N	N	N	P	N	P	P	N	N	N	N
172	P	P	P	P	N	N	N	N	N	P	P	P	N	N	N	N
177	P	P	P	P	N	N	N	N	N	P	P	N	N	N	N	P
178	P	P	P	P	N	N	N	N	N	P	N	P	N	N	N	N
179	P	P	P	P	N	N	N	N	N	P	N	P	N	N	N	N
180	P	P	P	P	N	N	N	N	P	P	P	N	N	N	N	P
181	P	P	P	P	N	N	N	N	N	P	N	P	N	N	N	N
182	P	P	N	P	N	N	N	N	N	N	N	P	N	N	N	N
183	P	P	P	P	N	N	N	N	P	N	N	P	N	N	N	N
189	P	P	NSC	NSC	N	N	NSC	NSC	P	P	NSC	NSC	N	N	NSC	NSC
190	NSC	P	NSC	NSC	NSC	N	NSC	NSC	NSC	N	NSC	NSC	NSC	N	NSC	NSC
191	P	P	NSC	NSC	N	N	NSC	NSC	N	P	NSC	NSC	N	N	NSC	NSC
192	P	P	NSC	NSC	N	N	NSC	NSC	P	N	NSC	NSC	N	N	NSC	NSC
193	P	P	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC
194	P	N	NSC	NSC	N	N	NSC	NSC	P	N	NSC	NSC	N	N	NSC	NSC
195	P	P	NSC	NSC	N	N	NSC	NSC	P	N	NSC	NSC	N	N	NSC	NSC
196	P	P	P	P	N	N	N	N	P	P	P	P	N	N	N	N
198	P	P	P	P	N	N	N	N	P	N	P	P	N	P	P	N
199	P	P	P	P	N	P	N	N	N	N	P	P	N	P	N	N
201	P	N	NSC	NSC	N	N	NSC	NSC	N	P	NSC	NSC	N	N	NSC	NSC
202	P	P	NSC	NSC	N	N	NSC	NSC	N	P	NSC	NSC	N	N	NSC	NSC
206	P	P	P	P	N	N	N	P	N	N	P	N	N	N	N	N
207	P	P	P	P	N	N	N	N	N	N	N	P	N	N	N	N
208	P	P	P	P	N	N	N	N	N	P	P	P	N	N	N	N
209	P	P	P	P	N	N	N	N	P	N	N	N	N	P	N	P
213	P	P	N	P	N	N	N	N	P	P	N	P	N	N	N	N
214	P	P	N	P	N	N	N	N	P	P	N	P	N	N	N	N
226	P	P	P	P	N	N	N	N	P	P	P	N	N	P	N	P
227	P	N	P	P	N	N	N	N	N	N	P	P	N	N	N	N
228	P	P	P	P	N	N	N	N	N	N	N	P	N	N	N	N
229	P	P	P	P	N	N	N	N	P	P	P	P	N	N	N	N
230	N	P	N	N	N	N	N	N	N	P	N	N	N	N	N	P
231	P	P	P	N	N	N	N	P	N	P	N	N	N	N	N	N
232	P	P	P	P	N	N	N	N	N	N	P	N	N	N	P	P
233	NSC	P	P	P	NSC	N	P	N	NSC	P	N	P	NSC	N	N	N
235	P	P	P	P	N	N	N	N	P	P	N	P	N	N	P	N
241	P	P	P	P	N	N	N	N	N	P	P	P	N	N	N	N

(continued)

TABLE A-10 (continued)

Participant I.D.	Streptococcus-alpha Period				Streptococcus-beta Period				Streptococcus-gamma Period				Staphylococcus aureus Period			
	1	2	4	5	1	2	4	5	1	2	4	5	1	2	4	5
242	P	P	P	P	N	N	N	N	P	P	P	P	N	N	N	N
243	N	P	N	N	N	P	N	P	N	P	N	N	N	P	N	P
244	P	P	P	P	N	N	N	N	N	P	P	P	N	P	N	N
254	P	NSC	NSC	NSC	N	NSC	NSC	NSC	N	NSC	NSC	NSC	N	NSC	NSC	NSC
255	P	P	P	NSC	N	N	N	NSC	P	P	P	NSC	N	N	N	NSC
256	P	P	P	NSC	N	N	N	NSC	N	P	N	NSC	N	N	N	NSC
257	P	P	P	NSC	N	N	N	NSC	P	P	P	NSC	N	P	N	NSC
258	P	P	P	NSC	N	N	N	NSC	P	P	P	NSC	N	N	N	NSC
260	P	P	P	P	N	N	N	N	P	P	P	P	N	N	N	N
262	P	P	N	P	N	N	N	N	N	P	P	P	N	N	N	N
263	N	P	P	P	N	N	N	N	P	P	N	P	N	P	N	P
266	P	P	N	P	N	N	N	N	P	N	P	N	N	N	N	P
267	P	P	P	P	N	N	N	N	P	P	N	N	N	N	N	N
269	P	P	N	P	N	N	N	N	N	P	P	P	N	N	N	N
273	NSC	P	P	P	NSC	N	N	N	NSC	P	P	P	NSC	N	N	N
275	P	P	P	P	N	N	N	N	P	P	N	P	N	N	P	N
276	P	P	P	P	N	N	N	N	N	N	P	P	N	P	N	N
278	P	P	N	N	N	N	N	N	N	P	N	N	N	N	N	P
284	N	N	P	P	N	N	N	N	P	N	N	P	N	N	N	N
290	P	P	N	P	N	N	N	N	P	P	N	P	N	N	N	N
293	P	P	NSC	NSC	N	N	NSC	NSC	N	P	NSC	NSC	N	N	NSC	NSC
294	P	P	N	P	N	N	N	N	P	P	P	P	N	N	N	N
302	P	P	P	P	N	N	N	N	N	N	N	P	N	N	N	N
303	P	P	N	P	N	N	N	N	P	P	P	P	N	N	N	N
312	P	P	P	P	N	N	N	N	P	P	P	P	N	P	N	N
313	P	P	P	P	N	N	N	N	N	P	P	N	N	N	N	P
314	N	P	P	P	N	N	N	N	N	P	P	P	N	N	N	N
315	P	P	P	N	N	N	N	N	P	N	P	N	N	N	N	P
316	P	N	N	P	N	N	N	N	P	N	N	P	N	N	N	N
324	P	P	P	P	N	N	N	N	N	P	P	P	N	N	N	N
325	P	P	P	P	N	N	N	N	N	P	P	P	N	N	N	N
330	P	P	P	P	N	N	N	N	P	P	P	P	N	N	N	N
334	P	P	P	N	N	N	N	N	N	P	P	N	N	N	N	N
335	P	P	N	P	N	N	N	N	N	P	N	P	N	N	N	N
336	P	P	N	N	N	N	N	N	P	P	N	N	N	N	N	P
337	P	P	N	N	N	N	N	N	P	P	N	N	N	N	N	P
338	P	P	N	P	N	N	N	N	P	N	N	P	N	N	N	N
339	P	P	P	P	N	N	N	P	P	P	P	N	N	N	N	N
340	P	P	N	P	N	N	N	N	N	P	P	P	N	N	N	N
341	P	P	N	P	N	N	N	N	N	P	N	N	P	N	N	N
342	P	P	NSC	P	N	N	NSC	N	P	P	NSC	N	N	N	NSC	N
343	P	P	N	P	N	N	N	N	N	N	N	P	N	N	N	N
348	P	P	N	P	N	N	P	N	P	P	P	P	N	N	N	N
349	P	P	P	P	N	N	N	N	N	P	P	P	N	N	N	N
350	N	P	P	P	N	N	N	N	N	P	P	N	N	N	N	P
353	P	P	P	P	N	N	N	N	N	P	N	P	N	N	N	N
354	P	P	N	N	N	N	N	N	N	P	P	N	N	N	N	P

(continued)

TABLE A-10 (continued)

Participant I.D.	Streptococcus-alpha				Streptococcus-beta				Streptococcus-gamma				Staphylococcus aureus			
	Period				Period				Period				Period			
	1	2	4	5	1	2	4	5	1	2	4	5	1	2	4	5
355	P	P	P	N	N	N	N	N	N	P	P	N	N	N	N	P
356	P	P	P	P	N	N	N	N	P	P	P	P	N	N	N	N
359	P	P	N	P	N	N	N	N	N	N	N	P	N	N	N	N
361	P	P	P	P	N	N	N	N	P	P	N	P	N	N	N	N
362	P	P	P	P	N	N	N	N	P	P	N	P	N	N	N	N
363	P	P	P	N	N	N	N	N	N	P	N	N	P	P	N	P
364	P	N	P	P	N	N	N	N	P	P	P	P	N	N	N	N
365	N	P	P	P	N	N	N	N	N	N	P	P	P	N	N	N
366	P	P	P	P	N	N	N	N	N	P	N	P	N	N	N	N
367	P	P	P	P	N	N	N	N	N	N	P	P	N	N	N	N
368	P	P	P	P	N	N	N	N	P	P	P	P	P	N	N	N
370	P	P	P	P	N	N	N	N	N	N	P	N	N	N	N	P
372	P	P	P	P	N	N	N	N	N	N	P	P	N	N	N	N
373	P	P	P	P	N	N	N	N	P	P	P	P	N	N	N	N
374	P	P	P	P	N	N	N	P	P	P	P	N	N	N	N	P
375	P	P	P	P	N	N	N	N	P	N	P	P	N	N	N	N
378	P	NSC	NSC	P	N	NSC	NSC	P	N	NSC	NSC	N	N	NSC	NSC	N
383	P	NSC	NSC	NSC	N	NSC	NSC	NSC	N	NSC	NSC	NSC	N	NSC	NSC	NSC
384	P	NSC	NSC	NSC	N	NSC	NSC	NSC	P	NSC	NSC	NSC	N	NSC	NSC	NSC
385	P	P	P	P	N	N	N	P	N	P	P	N	N	P	N	N
386	P	P	P	P	N	N	N	N	P	N	P	P	N	N	N	N
387	P	P	N	P	N	N	N	N	N	N	N	P	N	N	N	N
388	P	P	N	N	N	N	N	N	P	P	N	N	N	N	N	P
390	NSC	P	N	P	NSC	N	N	N	NSC	P	N	P	NSC	N	N	N
391	P	P	N	P	N	N	N	N	N	N	N	P	N	N	N	N
392	P	P	P	P	N	N	N	N	N	P	P	P	N	N	N	N
393	P	P	P	P	N	N	N	N	N	P	N	N	N	N	N	P
394	P	P	N	NSC	N	N	N	NSC	N	P	N	NSC	N	N	N	NSC
395	P	P	N	NSC	N	N	N	NSC	P	P	N	NSC	N	N	N	NSC
396	P	P	P	NSC	N	N	N	NSC	P	P	N	NSC	N	N	N	NSC
397	P	P	N	NSC	N	N	N	NSC	P	P	P	NSC	N	N	N	NSC
398	NSC	P	N	N	NSC	N	P	N	NSC	P	N	N	NSC	N	N	P
399	P	P	P	P	N	N	N	N	P	P	P	P	N	N	N	N
400	P	P	P	P	N	N	N	N	N	P	P	P	N	N	N	N
402	P	P	NSC	NSC	N	N	NSC	NSC	P	P	NSC	NSC	N	N	NSC	NSC
403	P	P	N	P	N	N	N	N	N	P	N	P	N	N	N	N
405	P	P	P	P	N	N	N	N	N	P	N	P	N	N	N	N
406	P	P	N	P	N	N	N	N	N	P	N	P	N	N	N	N
407	P	N	P	P	N	N	N	N	P	N	P	P	N	N	N	N
408	P	P	P	P	N	N	N	N	P	P	P	N	N	N	P	P
412	P	N	NSC	NSC	N	N	NSC	NSC	N	P	NSC	NSC	N	N	NSC	NSC
413	P	P	NSC	NSC	N	N	NSC	NSC	N	P	NSC	NSC	N	N	NSC	NSC
414	P	P	P	P	N	N	N	P	P	P	P	N	N	N	N	N
415	P	P	P	P	N	N	N	N	N	P	P	P	N	N	N	N
416	P	P	N	P	N	N	P	N	P	P	N	P	N	N	N	N
417	P	P	P	P	N	N	P	P	N	P	P	N	P	N	N	N
418	P	P	P	P	N	N	P	N	P	N	P	P	N	N	N	N

(continued)

TABLE A-10 (continued)

Participant I.D.	Streptococcus-alpha				Streptococcus-beta				Streptococcus-gamma				Staphylococcus aureus			
	Period				Period				Period				Period			
	1	2	4	5	1	2	4	5	1	2	4	5	1	2	4	5
419	P	P	P	P	N	N	N	N	P	N	N	P	N	N	N	N
421	P	P	N	P	N	N	N	N	N	P	N	P	N	N	N	N
422	P	P	N	P	N	N	N	N	P	P	N	P	N	N	N	N
423	NSC	P	P	P	NSC	N	N	N	NSC	P	N	P	NSC	N	N	N
424	P	P	P	P	N	N	N	N	P	P	N	P	N	N	N	N
426	P	P	P	N	N	N	N	N	P	P	N	N	N	N	N	P
428	P	P	P	N	N	N	N	N	N	P	N	N	N	N	N	N
429	P	P	P	P	N	N	N	N	N	P	N	P	N	N	N	N
430	P	P	P	P	N	N	N	N	N	P	P	N	N	N	P	P
438	P	P	NSC	NSC	N	N	NSC	NSC	N	P	NSC	NSC	N	N	NSC	NSC
441	P	P	P	P	N	N	N	N	N	P	N	P	N	N	N	N
442	P	P	P	P	N	N	N	N	P	P	P	P	N	N	N	N
443	P	P	P	P	N	N	N	N	P	P	N	N	N	P	N	P
445	P	P	P	P	N	N	P	N	N	P	P	N	P	N	N	N
446	P	P	P	P	N	N	P	N	P	P	P	P	N	N	N	N
449	P	N	P	P	N	N	N	N	N	P	N	P	N	N	N	N
450	P	P	P	P	N	N	N	N	N	P	P	P	N	P	N	N
451	P	P	P	P	N	N	P	N	N	P	P	N	N	P	N	P
452	P	P	P	NSC	N	N	N	NSC	N	P	P	NSC	N	N	N	NSC
453	P	P	P	NSC	N	N	N	NSC	P	P	P	NSC	N	N	N	NSC
454	P	P	P	NSC	N	N	N	NSC	N	P	P	NSC	N	N	N	NSC
455	P	P	N	P	N	N	N	N	N	P	P	P	N	N	N	N
457	P	P	P	P	N	N	N	N	P	P	N	P	N	N	N	N
458	P	P	P	P	N	N	N	N	N	N	N	P	N	N	N	N
459	P	P	N	N	N	N	P	N	P	N	P	N	N	N	N	P
460	P	P	P	P	N	N	N	N	P	P	N	N	N	N	N	P
461	P	P	P	P	N	N	N	N	N	P	P	P	N	P	N	N
464	P	N	P	N	N	N	N	N	P	P	P	N	N	N	N	P
465	P	P	P	P	N	N	N	N	P	P	P	P	N	N	N	N
466	P	P	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC
467	P	P	NSC	NSC	N	N	NSC	NSC	P	N	NSC	NSC	N	N	NSC	NSC
500	NSC	NSC	P	P	NSC	NSC	N	N	NSC	NSC	P	N	NSC	NSC	N	N
501	P	P	NSC	NSC	N	N	NSC	NSC	N	P	NSC	NSC	N	N	NSC	NSC
502	P	P	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC
503	P	P	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC	N	N	NSC	NSC
504	P	P	P	P	N	N	N	N	P	P	N	N	N	N	N	P
505	P	NSC	P	N	N	NSC	N	N	N	NSC	P	N	N	NSC	N	P
506	P	N	N	P	N	N	N	N	N	N	N	P	N	P	N	N
507	P	P	N	P	N	N	N	N	N	P	N	P	N	P	N	N
508	P	P	N	N	N	N	P	N	N	N	P	N	P	P	N	P
509	P	P	P	N	N	N	N	N	P	P	P	N	N	N	N	N
510	P	P	P	P	N	N	N	P	N	P	P	N	N	N	N	N
512	P	P	P	P	N	N	N	N	N	P	P	P	N	N	N	N

(continued)

TABLE A-10 (continued)

Participant I.D.	Streptococcus-alpha		Streptococcus-beta		Streptococcus-gamma		Staphylococcus aureus	
	Period		Period		Period		Period	
	3	5	3	5	3	5	3	5
600	P	P	N	N	P	P	N	N
601	P	P	N	N	P	P	N	N
602	N	P	N	N	N	P	N	N
603	N	P	N	N	N	P	N	N
604	P	NSC	N	NSC	N	NSC	N	NSC
605	P	NSC	N	NSC	N	NSC	N	NSC
606	P	NSC	P	NSC	P	NSC	N	NSC
607	P	NSC	N	NSC	N	NSC	N	NSC
608	P	NSC	N	NSC	N	NSC	N	NSC
609	N	NSC	N	NSC	N	NSC	N	NSC
611	N	NSC	N	NSC	N	NSC	N	NSC
612	N	NSC	N	NSC	P	NSC	N	NSC
613	N	NSC	N	NSC	P	NSC	N	NSC
614	N	P	N	N	N	N	N	P
615	P	P	N	N	P	P	N	N
616	P	P	N	N	P	P	N	N
617	P	P	N	N	P	P	N	N
618	P	NSC	N	NSC	N	NSC	N	NSC
619	P	N	N	N	P	N	N	N
620	P	NSC	N	NSC	N	NSC	P	NSC
621	N	P	N	N	N	P	N	N
622	P	P	N	N	N	P	P	N
623	P	P	N	N	N	P	N	N
624	P	NSC	N	NSC	N	NSC	N	NSC
625	P	NSC	N	NSC	N	NSC	N	NSC
626	P	NSC	N	NSC	N	NSC	N	NSC
628	P	P	N	N	N	P	N	N
629	P	P	N	N	P	P	N	N
630	P	P	N	N	N	P	N	N
631	N	P	N	N	P	N	N	P
632	P	P	N	N	N	P	N	N
633	P	P	N	N	N	N	N	P
634	NSC	P	NSC	N	NSC	P	NSC	N
637	P	NSC	N	NSC	N	NSC	N	NSC
640	P	P	N	N	N	P	N	N
641	P	P	N	N	N	P	N	N
642	N	P	N	N	N	N	N	N
643	P	P	N	N	P	N	N	P
644	P	P	N	N	N	P	N	N
645	NSC	P	NSC	P	NSC	N	NSC	N
646	P	P	N	N	N	N	N	P
647	P	P	N	N	N	P	N	N
648	P	P	P	P	N	N	N	N
649	P	P	N	N	P	P	N	N
650	P	P	N	N	N	P	N	N
651	P	NSC	N	NSC	P	NSC	N	NSC
652	P	P	N	N	N	P	N	N
653	N	P	P	N	P	P	N	N
654	N	P	N	N	P	P	N	N
655	P	NSC	N	NSC	P	NSC	N	NSC

TABLE A-11 PARASITE ISOLATIONS IN FECES SAMPLES FROM INDIVIDUAL PARTICIPANTS

Participant I.D.	Period 1	Period 2	Period 4	Period 5
1	N	N	N	N
2	N	NSC	N	NSC
3	N	NSC	N	N
4	N	N	N	NSC
5	N	N	N	NSC
6	N	N	N	N
9	N	NSC	N	N
10	N	N	NSC	N
11	N	N	N	N
12	N	N	N	NSC
13	N	N	N	N
14	N	N	N	NSC
15	N	N	NSC	NSC
16	N	N	NSC	N
18	N	N	N	NSC
19	N	N	N	N
29	N	N	N	N
30	N	N	N	N
31	N	N	N	N
32	N	N	N	N
33	N	N	N	N
45	N	NSC	NSC	NSC
49	NSC	N	N	N
50	N	N	N	N
74	N	N	N	N
75	N	N	N	N
76	NSC	NSC	N	N
77	N	NSC	N	N
78	N	NSC	N	N
79	NSC	NSC	NSC	N
80	NSC	NSC	N	NSC
82	NSC	NSC	NSC	N
83	N	N	NSC	N
84	N	N	N	N
97	N	N	N	N
98	N	N	N	N
99	N	N	N	N
100	N	N	N	NSC
101	N	N	N	N
102	N	N	N	NSC
103	N	N	N	NSC
113	N	N	NSC	NSC
114	N	N	NSC	NSC
115	N	N	NSC	NSC
116	N	NSC	NSC	NSC
117	N	NSC	NSC	NSC
131	N	N	N	NSC
141	N	N	NSC	N
142	N	N	N	N
143	N	N	N	N

(continued)

TABLE A-11 (continued)

Participant I.D.	Period 1	2	4	5
144	N	N	N	NSC
145	N	NSC	N	N
146	N	N	N	N
157	N	N	N	N
158	N	N	N	N
159	N	N	NSC	N
160	N	NSC	N	N
162	N	N	N	NSC
165	N	N	N	N
166	N	N	N	N
171	N	N	N	N
172	N	N	N	NSC
177	N	N	N	N
178	N	N	N	N
179	N	N	N	N
180	N	N	N	N
181	N	N	N	N
182	N	N	N	NSC
183	N	N	N	N
196	N	N	N	NSC
198	N	N	N	NSC
199	N	NSC	N	NSC
201	N	N	NSC	NSC
202	N	N	NSC	NSC
206	N	N	N	N
207	N	NSC	N	N
208	N	N	N	N
209	N	N	N	N
213	N	N	N	NSC
214	N	N	N	NSC
226	N	N	NSC	N
227	N	N	NSC	N
228	N	N	NSC	N
229	N	NSC	N	N
230	NSC	N	N	N
231	N	N	N	N
232	N	N	N	N
233	N	N	N	NSC
235	N	N	N	NSC
239	N	NSC	NSC	NSC
240	N	NSC	NSC	NSC
241	P^5	N	P^6	P^5
242	N	N	N	N
243	N	N	N	NSC
244	N	NSC	N	N
252	NSC	N	NSC	NSC
254	N	NSC	NSC	NSC
255	NSC	N	NSC	NSC
256	N	N	N	NSC
257	N	N	N	NSC

(continued)

TABLE A-11 (continued)

Participant I.D.	Period			
	1	2	4	5
258	N	N	N	NSC
260	NSC	N	N	N
262	N	N	NSC	NSC
263	N	N	N	N
266	N	N	N	N
267	NSC	N	N	N
268	N	N	NSC	N
273	N	N	N	NSC
275	N	NSC	N	NSC
276	N	N	N	NSC
278	N	N	N	NSC
284	N	N	N	N
290	N	N	N	N
293	NSC	N	NSC	NSC
294	NSC	NSC	NSC	N
302	N	N	N	N
303	N	N	N	N
312	N	N	NSC	N
313	N	N	N	N
314	N	N	N	NSC
315	N	N	N	N
316	N	P^2	P^2	P^2
324	N	N	N	N
325	N	N	N	N
330	N	N	N	N
334	NSC	N	N	N
335	N	N	N	N
336	N	N	N	N
337	N	N	N	P^5
338	N	NSC	N	N
339	NSC	N	N	N
340	N	NSC	N	NSC
341	NSC	N	NSC	N
342	N	N	NSC	NSC
343	N	N	N	N
348	N	N	N	N
349	N	N	N	N
350	N	N	N	N
353	N	N	N	NSC
354	N	N	N	N
355	N	N	N	N
356	N	N	N	N
359	N	N	N	P^1
361	N	N	N	N
362	N	N	N	NSC
363	N	N	NSC	NSC
364	N	NSC	N	N
365	N	N	N	N
366	NSC	N	N	N
367	N	N	N	N

(continued)

TABLE A-11 (continued)

Participant I.D.	Period 1	2	4	5
368	N	N	N	N
370	NSC	N	N	NSC
372	N	N	N	N
373	N	NSC	P[2]	NSC
374	N	N	N	NSC
375	N	N	N	NSC
378	N	NSC	NSC	N
383	N	NSC	NSC	NSC
384	N	NSC	NSC	NSC
385	NSC	N	N	N
386	N	NSC	N	N
387	N	N	N	NSC
388	N	N	N	N
390	N	N	N	N
391	N	N	N	N
392	N	N	N	N
393	N	N	N	N
394	P[3]	NSC	N	NSC
395	N	N	N	NSC
396	N	N	N	NSC
397	N	N	N	NSC
398	N	N	N	NSC
399	N	N	N	N
400	N	N	N	N
402	N	NSC	NSC	NSC
403	N	N	N	N
405	N	N	N	N
406	NSC	NSC	N	N
407	N	N	NSC	N
408	NSC	N	N	N
412	NSC	N	NSC	NSC
413	NSC	N	NSC	NSC
414	N	N	N	N
415	N	N	N	NSC
416	N	N	N	N
417	NSC	N	N	NSC
418	N	N	N	NSC
419	N	N	N	N
421	N	N	N	N
422	N	N	N	N
423	N	N	N	NSC
424	N	N	N	N
426	NSC	N	N	N
428	N	N	NSC	NSC
429	N	N	N	N
430	N	N	N	N
438	N	N	NSC	NSC
441	N	N	N	N
442	N	N	N	N
443	N	NSC	N	N

(continued)

TABLE A-11 (continued)

Participant I.D.	Period 1	Period 2	Period 4	Period 5
445	N	NSC	N	N
446	N	N	N	NSC
449	N	N	N	N
450	NSC	N	N	NSC
451	N	N	N	NSC
452	NSC	N	N	NSC
453	N	N	NSC	NSC
454	N	N	N	NSC
455	N	N	N	N
457	N	N	N	N
458	N	N	N	NSC
459	N	N	N	N
460	N	N	N	N
461	N	N	N	NSC
464	N	N	N	N
465	N	N	N	N
466	NSC	N	NSC	NSC
467	N	N	NSC	NSC
500	NSC	NSC	NSC	NSC
501	NSC	N	NSC	NSC
502	N	N	NSC	NSC
503	NSC	N	NSC	NSC
504	NSC	N	N	NSC
505	N	NSC	N	NSC
506	N	NSC	N	N
507	NSC	N	N	NSC
508	N	N	N	N
509	N	N	N	N
510	N	N	N	N
512	NSC	N	P[4]	N

	Period 3	Period 5
600	N	N
601	N	N
602	N	N
603	N	N
604	N	NSC
605	N	NSC
606	NSC	NSC
607	N	NSC
608	N	NSC
609	N	NSC
610	NSC	N
611	N	NSC
612	N	NSC
613	N	NSC
614	N	N
615	N	N

(continued)

TABLE A-11 (continued)

Participant I.D.	Period	
	3	5
616	N	NSC
617	N	N
618	N	N
619	N	N
620	N	NSC
621	N	N
622	N	N
623	N	N
624	N	NSC
625	N	NSC
626	N	NSC
627	NSC	NSC
628	N	N
629	N	N
630	N	N
631	N	N
632	N	N
633	N	NSC
634	N	N
635	NSC	NSC
636	NSC	NSC
637	N	NSC
638	NSC	NSC
639	NSC	NSC
640	NSC	N
641	N	N
642	N	N
643	N	N
644	N	N
645	N	N
646	N	N
647	N	N
648	N	N
649	N	NSC
650	N	N
651	N	N
652	N	N
653	NSC	N
654	NSC	N

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[1] Chilomastix mesnili
[2] Entamoeba coli
[3] Entamkoeba hartmanni
[4] Endolimax nana
[5] Giardia-lambia
[6] Trichomonas

TABLE A-12 VIRAL ISOLATIONS IN FECES SAMPLES AND THROAT SWABS FROM INDIVIDUAL PARTICIPANTS

Participant I.D.	Feces (Picornaviruses)				Throat Swab (All viruses)			
	Period				Period			
	1	2	4	5	1	2	4	5
1	N	P	P	N	N	N	N	N
2	N	NSC	P	P	N	NSC	N	N
3	N	NSC	P	N	N	NSC	N	N
4	N	P	P	N	N	N	N	N
5	N	P	N	N	N	N	N	N
6	N	N	N	N	N	N	N	N
9	N	NSC	N	N	N	N	N	N
10	N	N	N	N	N	N	N	N
11	N	N	N	N	N	N	N	N
12	N	N	N	N	N	N	N	N
13	N	N	N	N	N	N	N	N
14	N	N	N	N	N	N	N	N
15	N	N	N	NSC	N	N	N	N
16	N	N	N	N	N	N	N	NSC
18	N	N	N	N	N	N	N	N
19	N	N	N	N	N	N	N	N
29	N	N	N	N	N	N	N	N
30	N	N	N	N	N	N	N	N
31	N	N	N	N	N	N	N	N
32	N	N	N	N	N	N	N	N
33	N	N	N	N	N	N	N	N
49	NSC	N	N	NSC	N	N	N	N
50	NSC	N	N	N	N	N	N	N
74	N	N	N	N	N	N	N	N
75	N	N	N	N	N	N	N	N
76	NSC	NSC	N	NSC	N	N	N	N
77	N	N	N	N	N	N	N	N
78	N	NSC	N	NSC	N	N	N	N
83	N	N	N	N	N	N	N	N
84	N	N	N	N	N	N	N	N
97	N	N	N	N	N	N	N	N
98	N	N	N	N	N	N	N	N
99	N	N	N	N	N	N	N	N
100	N	N	N	N	N	N	N	N
101	N	N	N	N	N	N	N	N
102	N	N	N	N	N	N	N	N
103	N	N	N	N	N	N	N	N
113	N	N	NSC	NSC	N	N	NSC	NSC
114	N	N	NSC	NSC	N	N	NSC	NSC
115	N	N	NSC	NSC	N	N	NSC	NSC
116	N	NSC	NSC	NSC	N	N	NSC	NSC
117	N	NSC	NSC	NSC	N	N	NSC	NSC
131	N	N	N	N	N	N	N	N
141	N	N	N	N	N	N	N	N
142	N	N	N	N	N	N	N	N
143	N	N	N	N	N	N	N	N
144	N	N	N	NSC	N	N	N	N
145	N	N	N	N	N	N	N	N
146	N	N	N	N	N	N	N	N
157	N	N	N	N	N	N	N	N
158	N	N	N	N	N	N	N	N
159	N	N	N	N	N	N	N	N
160	N	NSC	N	N	N	N	N	N
162	N	N	N	N	N	N	N	N
165	N	N	N	N	N	N	N	N
166	N	N	N	N	N	N	N	N
167	N	NSC	NSC	NSC	N	NSC	NSC	NSC
171	N	N	N	N	N	N	N	N
172	N	N	N	N	N	N	N	N
177	N	N	N	N	N	N	N	N
178	N	N	N	N	N	N	N	N
179	N	N	N	N	N	N	N	N
180	N	N	N	N	N	N	N	N
181	N	N	N	NSC	N	N	N	N
182	N	N	N	N	N	N	N	N
183	N	N	N	N	N	N	N	N
189	N	N	NSC	NSC	N	N	NSC	NSC
190	N	N	NSC	NSC	N	N	NSC	NSC

(continued)

TABLE A-12 (continued)

Participant I.D.	Feces (Picornaviruses)				Throat Swab (All viruses)			
	Period				Period			
	1	2	4	5	1	2	4	5
191	N	N	NSC	NSC	N	N	NSC	NSC
192	N	N	NSC	NSC	N	N	NSC	NSC
193	N	N	NSC	NSC	N	N	NSC	NSC
194	N	N	NSC	NSC	N	N	NSC	NSC
195	N	N	NSC	NSC	N	N	NSC	NSC
196	N	N	N	N	N	N	N	N
198	N	N	N	N	N	N	N	N
199	N	NSC	N	N	N	N	N	N
201	N	N	NSC	NSC	N	N	NSC	NSC
202	N	N	NSC	NSC	N	N	NSC	NSC
206	N	N	N	N	N	N	N	N
207	N	N	N	N	N	N	N	N
208	N	N	N	N	N	N	N	N
209	N	N	N	N	N	N	N	N
213	N	N	P	N	N	N	N	N
214	N	N	N	N	N	N	N	N
226	N	N	N	N	N	N	N	N
227	N	N	N	P	N	N	N	N
228	N	N	N	N	N	N	N	N
229	N	N	N	P	N	N	N	N
230	NSC	N	N	N	N	N	N	N
231	N	N	N	N	N	N	N	N
232	N	N	N	N	N	N	N	N
233	N	N	N	N	N	N	N	N
235	N	P	N	N	N	N	N	N
241	N	N	N	N	N	N	N	N
242	N	N	N	N	N	N	N	N
243	N	N	N	NSC	N	N	N	N
244	N	NSC	N	N	N	N	N	N
254	N	N	NSC	NSC	N	NSC	NSC	NSC
255	N	N	N	NSC	N	N	N	NSC
256	N	N	N	NSC	N	N	N	NSC
257	N	N	N	NSC	N	N	N	NSC
258	N	N	N	NSC	N	N	N	NSC
260	N	N	N	N	N	N	N	N
262	N	N	N	N	N	N	N	NSC
263	N	N	N	N	N	N	N	N
266	N	N	N	N	N	N	N	N
267	N	N	N	N	N	N	N	N
268	N	N	N	N	N	N	N	N
273	N	N	N	N	N	N	N	N
275	N	N	N	N	N	N	N	N
276	N	N	N	NSC	N	N	N	N
278	N	N	N	N	N	N	N	N
284	N	N	N	P	N	N	N	N
290	N	N	N	N	N	N	N	N
293	NSC	N	NSC	NSC	N	N	NSC	NSC
294	NSC	NSC	N	N	N	N	N	N
302	N	N	N	N	N	N	N	N
303	N	N	N	NSC	N	N	N	N
312	N	N	N	N	N	N	N	N
313	N	N	N	N	N	N	N	N
314	N	N	N	NSC	N	N	N	N
315	N	N	N	N	N	N	N	N
316	N	N	N	N	N	N	N	N
324	N	N	N	N	N	N	N	N
325	N	N	N	N	N	N	N	N
330	N	N	N	P	N	N	N	N
334	NSC	N	N	N	N	N	N	N
335	N	N	N	N	N	N	N	N
336	N	N	N	N	N	N	N	N
337	N	N	N	N	N	N	N	N
338	N	NSC	N	N	N	N	N	N
339	NSC	N	N	N	N	N	N	N
340	N	NSC	N	N	N	N	N	N
341	NSC	N	N	N	N	N	N	N
342	N	N	N	N	N	N	NSC	N
343	N	N	N	N	N	N	N	N

(continued)

TABLE A-12 (continued)

Participant I.D.	Feces (Picornaviruses) Period 1	2	4	5	Throat Swab (All viruses) Period 1	2	4	5
348	N	N	N	N	N	N	N	N
349	N	N	N	N	N	N	N	N
350	N	N	N	N	N	N	N	N
353	N	N	N	NSC	N	N	N	N
354	N	N	N	NSC	N	N	N	N
355	N	N	N	N	N	N	N	N
356	N	N	N	N	N	N	N	N
359	N	N	N	N	N	N	N	N
361	N	N	N	N	N	N	N	N
362	N	N	N	N	N	N	N	N
363	N	N	N	NSC	N	N	N	N
364	N	N	N	N	N	N	N	N
365	N	N	N	N	N	N	N	N
366	NSC	N	N	NSC	N	N	N	N
367	N	N	N	N	N	N	N	N
368	N	N	N	N	N	N	N	N
370	NSC	N	N	N	N	N	N	N
372	N	N	N	N	N	N	N	N
373	N	NSC	N	N	N	N	N	N
374	NSC	N	N	N	N	N	N	N
375	N	N	P	NSC	N	N	N	N
378	N	N	N	N	N	NSC	NSC	N
383	N	NSC	NSC	NSC	N	NSC	NSC	NSC
384	N	NSC	NSC	NSC	N	NSC	NSC	NSC
385	NSC	N	N	N	N	N	N	N
386	N	NSC	N	N	N	N	N	N
387	N	N	N	NSC	N	N	N	N
388	N	N	N	N	N	N	N	N
390	N	N	N	N	N	N	N	N
391	N	N	P	N	N	N	N	N
392	N	N	P	NSC	N	N	N	N
393	N	N	N	N	N	N	N	N
394	N	NSC	N	NSC	N	N	N	NSC
395	N	N	N	NSC	N	N	N	NSC
396	N	N	N	NSC	N	N	N	NSC
397	N	N	N	NSC	N	N	N	NSC
398	N	N	N	N	N	N	N	N
399	N	N	P	N	N	N	N	N
400	N	N	N	N	N	N	N	N
402	N	NSC	NSC	NSC	N	N	NSC	NSC
403	N	N	N	N	N	N	N	N
405	N	N	N	N	N	N	N	N
406	N	NSC	N	N	N	N	N	N
407	N	N	N	N	N	N	N	N
408	NSC	N	N	N	N	N	N	N
412	N	N	NSC	NSC	N	N	NSC	NSC
413	NSC	N	NSC	NSC	N	N	NSC	NSC
414	N	N	N	N	N	N	N	N
415	N	N	N	NSC	N	N	N	N
416	N	N	N	N	N	N	N	N
417	NSC	N	N	NSC	N	N	N	N
418	N	N	N	NSC	N	N	N	N
419	N	N	N	NSC	N	N	N	N
421	N	N	N	P	N	N	N	N
422	N	N	N	N	N	N	N	N
423	N	N	N	N	N	N	N	N
424	N	N	N	P	N	N	N	N
426	N	N	N	N	N	N	N	N
428	N	N	N	NSC	N	N	N	N
429	N	N	N	N	N	N	N	N
430	N	N	N	N	N	N	N	N
438	N	N	NSC	NSC	N	N	NSC	NSC
441	N	N	N	N	N	N	N	N
442	N	N	N	N	N	N	N	N
443	N	NSC	N	N	N	N	N	N
445	N	NSC	N	N	N	N	N	N
446	N	N	N	NSC	N	NSC	N	N
449	N	N	N	N	N	N	NSC	N

(continued)

TABLE A-12 (continued)

Participant I.D.	Feces (Picornaviruses)				Throat Swab (All viruses)			
	Period				Period			
	1	2	4	5	1	2	4	5
450	NSC	N	N	NSC	N	N	N	N
451	N	N	N	NSC	N	N	N	N
452	N	N	N	NSC	N	N	N	NSC
453	N	N	N	NSC	N	N	N	NSC
454	N	N	N	NSC	N	N	N	NSC
455	N	N	N	N	N	N	N	N
457	N	N	N	N	N	N	N	N
458	N	N	N	N	N	N	N	N
459	N	N	N	N	N	N	N	N
460	N	N	N	N	N	N	N	N
461	N	N	N	NSC	N	N	N	N
464	N	N	N	N	N	N	N	N
465	N	N	N	N	N	N	N	N
466	NSC	N	N	NSC	N	N	NSC	N
467	N	N	N	NSC	N	N	NSC	NSC
500	N	NSC	N	NSC	N	NSC	N	N
501	NSC	N	NSC	NSC	N	N	NSC	NSC
502	N	N	NSC	NSC	N	N	NSC	NSC
503	NSC	N	NSC	NSC	N	N	NSC	NSC
504	NSC	N	N	N	N	N	N	N
505	N	NSC	N	N	N	NSC	N	N
506	N	NSC	N	N	N	N	N	N
507	NSC	N	N	NSC	N	N	N	N
508	NSC	N	N	N	N	N	N	N
509	N	N	N	N	N	N	N	N
510	N	N	N	N	N	N	N	N
512	N	N	N	N	N	N	N	N

	Period		Period	
	3	5	3	5
600	N	NSC	N	N
601	N	N	N	N
602	N	N	N	N
603	N	N	N	N
604	NSC	NSC	N	NSC
605	N	NSC	N	NSC
606	NSC	NSC	N	NSC
607	N	NSC	N	NSC
608	N	NSC	N	NSC
609	N	NSC	N	NSC
611	N	NSC	N	NSC
612	N	NSC	N	NSC
613	N	NSC	N	NSC
614	N	N	N	N
615	N	N	N	N
616	N	N	N	N
617	N	N	N	N
618	N	NSC	N	NSC
619	N	N	N	N
620	N	NSC	N	NSC
621	N	N	N	N
622	N	N	N	N
623	N	N	N	N
624	N	NSC	N	NSC
625	N	NSC	N	NSC
626	NSC	NSC	N	NSC
627	N	NSC	NSC	NSC
628	N	N	N	N
629	N	N	N	N
630	N	N	N	N
631	N	N	N	N
632	N	N	N	N
633	N	NSC	N	N
634	N	N	N	N
637	N	NSC	N	NSC
640	NSC	N	N	N
641	N	N	N	N
642	N	N	N	N
643	N	N	N	N
644	N	N	N	N
645	N	N	NSC	N
646	N	N	N	N
647	N	N	N	N
648	N	N	N	N
649	N	NSC	N	N
650	N	N	N	N
651	N	N	N	N
652	N	N	N	N
653	NSC	P	NSC	N
654	NSC	N	N	N

TABLE A-13 COXSACKIEVIRUS AND POLIOVIRUS ANTIBODY TITERS FROM ALL INDIVIDUAL PARTICIPANTS

Participant I.D.	Coxsackievirus B-1*				Poliovirus Type 1†				Poliovirus Type 2†				Poliovirus Type 3†			
	Period				Period				Period				Period			
	1	2	4	5	1	2	4	5	1	2	4	5	1	2	4	5
1	<10	<10	<10	NSC	10	10	10	NSC	100	100	100	NSC	100	100	100	NSC
2	<10	NSC	<10	<10	100	NSC	100	100	100	NSC	100	10	10	NSC	10	10
3	<10	NSC	10	10	100	NSC	100	100	100	NSC	10	10	10	NSC	10	10
4	10	10	<10	<10	100	100	100	100	10	10	10	10	10	10	10	<10
5	<10	<10	<10	<10	100	100	100	100	100	100	100	100	10	10	10	10
6	<10	<10	<10	<10	100	100	100	100	100	100	10	100	10	10	10	10
9	<10	<10	NSC	<10	10	10	NSC	10	100	100	NSC	100	10	10	NSC	10
10	<10	<10	<10	<10	100	100	100	100	100	100	100	100	10	10	10	10
11	<10	10	10	10	100	100	100	100	100	100	100	10	100	100	100	100
12	10	40	40	20	10	10	10	10	10	10	10	10	<10	<10	<10	<10
13	<10	<10	<10	<10	10	10	10	10	10	100	100	100	<10	10	<10	10
14	<10	<10	<10	<10	10	10	10	100	10	10	10	10	10	10	10	100
15	<10	<10	<10	<10	10	100	100	100	10	100	100	100	100	100	100	100
16	<10	10	<10	10	10	<10	10	10	100	100	100	100	10	10	10	10
18	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
19	<10	<10	<10	<10	10	10	10	10	10	10	10	10	100	100	100	100
29	<10	<10	<10	<10	10	10	10	10	10	10	10	10	10	10	10	10
30	<10	<10	<10	<10	10	10	10	10	100	100	100	100	10	10	10	10
31	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
32	<10	10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
33	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
49	20	20	10	<10	100	100	100	100	100	100	100	100	100	100	100	100
50	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
74	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
75	<10	<10	<10	<10	100	100	100	100	10	10	100	10	10	10	10	10
76	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
77	<10	<10	<10	NSC	100	100	100	NSC	10	10	10	NSC	100	100	100	NSC
78	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
83	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
84	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
97	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
98	NSC	<10	<10	<10	NSC	100	100	100	NSC	100	100	100	NSC	100	100	100
99	<10	<10	<10	<10	100	100	100	100	100	100	100	100	10	10	10	10
100	<10	<10	<10	10	10	10	10	10	10	10	10	10	10	10	10	10
101	<10	<10	<10	<10	10	10	10	10	10	10	10	10	10	10	10	10
102	<10	<10	<10	<10	100	100	100	100	10	10	10	10	100	100	100	100
103	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
113	10	20	NSC	NSC	10	10	NSC	NSC	10	10	NSC	NSC	10	10	NSC	NSC
114	<10	<10	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC
115	<10	<10	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC
116	<10	<10	NSC	NSC	10	10	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC
117	<10	<10	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC
131	<10	<10	<10	NSC	100	100	100	NSC	100	100	100	NSC	100	100	100	NSC
141	<10	10	10	<10	10	100	100	100	100	100	100	100	100	100	100	100
142	<10	<10	<10	<10	10	10	10	10	10	10	10	10	10	10	10	10
143	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
144	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100

(continued)

TABLE A-13 (continued)

Participant I.D.	Coxsackievirus B-1*				Poliovirus Type 1†				Poliovirus Type 2†				Poliovirus Type 3†			
	Period				Period				Period				Period			
	1	2	4	5	1	2	4	5	1	2	4	5	1	2	4	5
145	80	40	40	20	100	100	100	100	100	100	100	100	100	100	100	100
146	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
157	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
158	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
159	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
160	NSC	<10	<10	<10	NSC	10	10	10	NSC	10	10	10	NSC	10	10	10
162	10	10	10	<10	100	100	100	100	100	100	100	100	100	100	100	100
165	<10	<10	<10	<10	10	100	100	100	100	100	100	100	100	100	100	100
166	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
167	<10	NSC	NSC	NSC	100	NSC	NSC	NSC	NSC	NSC	NSC	NSC	100	NSC	NSC	NSC
171	NSC	20	40	40	NSC	100	100	100	NSC	10	10	10	NSC	10	10	10
172	<10	<10	10	10	100	100	100	100	100	100	100	100	100	100	100	100
177	<10	<10	<10	10	100	100	100	100	100	100	100	100	100	100	100	100
178	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
179	<10	<10	<10	<10	100	100	100	100	10	100	100	10	100	100	100	100
180	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
181	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
182	<10	<10	<10	<10	100	100	100	100	100	100	100	100	10	10	10	10
183	NSC	<10	<10	<10	NSC	10	10	10	NSC	10	10	10	NSC	10	10	10
189	<10	<10	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC
190	10	40	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC	10	10	NSC	NSC
191	<10	40	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC
192	<10	<10	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC
193	<10	10	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC	10	10	NSC	NSC
194	<10	<10	NSC	NSC	10	10	NSC	NSC	10	10	NSC	NSC	10	10	NSC	NSC
195	NSC	20	NSC	NSC	NSC	100	NSC	NSC	NSC	100	NSC	NSC	NSC	100	NSC	NSC
196	<10	<10	10	<10	100	100	100	100	100	100	100	100	100	100	100	100
198	<10	<10	<10	NSC	100	100	100	NSC	100	100	100	NSC	100	100	100	NSC
199	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
201	<10	<10	NSC	NSC	100	100	NSC	NSC	10	10	NSC	NSC	100	100	NSC	NSC
202	NSC	<10	NSC	NSC	NSC	NSC	NSC	NSC	NSC	100	NSC	NSC	NSC	100	NSC	NSC
206	<10	10	<10	<10	10	10	100	100	100	100	100	100	10	10	10	10
207	<10	10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
208	<10	10	<10	<10	10	10	100	100	100	10	100	100	10	10	10	01
209	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
213	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
214	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
226	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
227	<10	20	10	20	100	100	100	100	10	10	10	10	100	100	100	100
228	<10	20	10	20	100	100	100	100	100	100	100	100	100	100	100	100
229	<10	<10	<10	<10	100	100	100	100	100	100	100	100	10	10	10	10
230	<10	<10	NSC	NSC	10	100	NSC	NSC	10	10	NSC	NSC	100	100	NSC	NSC
231	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
232	NSC	NSC	<10	<10	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC	100	100
233	<10	<10	<10	<10	100	100	10	100	100	100	100	100	100	100	100	100
235	NSC	NSC	NSC	<10	NSC	NSC	NSC	NSC	NSC	NSC	NSC	100	NSC	NSC	NSC	100
241	<10	40	20	20	100	100	100	100	100	100	100	100	100	100	100	100

(continued)

TABLE A-13 (continued)

Participant I.D.	Coxsackievirus B-1*				Poliovirus Type 1†				Poliovirus Type 2†				Poliovirus Type 3†			
	Period				Period				Period				Period			
	1	2	4	5	1	2	4	5	1	2	4	5	1	2	4	5
242	<10	20	20	20	100	100	100	100	100	100	100	100	100	100	100	100
243	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
244	<10	10	NSC	<10	100	100	100	100	100	100	100	100	100	100	100	100
254	<10	NSC	NSC	NSC	100	NSC	NSC	NSC	100	NSC	NSC	NSC	100	NSC	NSC	NSC
255	<10	<10	<10	NSC	100	100	100	NSC	100	100	100	NSC	100	100	100	NSC
256	<10	20	<20	NSC	100	100	100	NSC	100	100	100	NSC	100	100	100	NSC
257	NSC	<10	10	NSC	NSC	10	10	NSC	NSC	100	100	NSC	NSC	100	100	NSC
258	<10	10	10	NSC	10	10	10	NSC	10	10	10	NSC	10	10	10	NSC
260	<10	<10	<10	10	10	10	10	10	10	10	10	10	10	10	10	10
262	<10	<10	<10	<10	100	100	100	100	100	100	100	100	10	10	10	10
263	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
266	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
267	<10	<10	<10	<10	<10	<10	<10	<10	10	10	10	10	<10	<10	<10	<10
268	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
273	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
275	10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
276	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
278	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
284	<10	<10	<10	<10	100	100	100	100	10	10	10	10	100	100	100	100
290	10	10	10	<10	100	100	100	100	10	10	10	10	100	100	100	100
293	<10	NSC	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC
294	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
302	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
303	NSC	<10	<10	<10	NSC	10	10	10	NSC	10	10	10	NSC	10	10	10
312	20	10	<10	<10	10	10	10	10	100	100	100	100	10	10	10	10
313	<10	<10	<10	<10	100	100	100	100	100	100	100	100	10	10	10	10
314	<10	<10	<10	NSC	100	100	100	NSC	100	100	100	NSC	100	100	100	NSC
315	NSC	<10	<10	<10	NSC	100	100	100	NSC	10	10	10	NSC	100	100	100
316	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
324	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
325	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
330	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
334	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
335	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
336	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
337	<10	<10	<10	<10	10	10	10	10	<10	10	10	10	10	10	10	10
338	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	10	10	100
339	<10	<10	<10	<10	10	10	10	10	10	10	10	10	10	100	100	10
340	NSC	NSC	NSC	<10	NSC	NSC	NSC	10	NSC	NSC	NSC	10	NSC	NSC	NSC	10
341	NSC	<10	<10	<10	NSC	100	100	100	NSC	100	100	100	NSC	100	100	100
342	NSC	<10	NSC	NSC	NSC	100	NSC	NSC	NSC	100	NSC	NSC	NSC	100	NSC	NSC
343	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
348	<10	NSC	<10	<10	100	NSC	100	100	100	NSC	100	100	100	NSC	100	100
349	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
350	<10	<10	<10	<10	10	10	10	10	10	10	10	10	10	10	10	10
353	<10	<10	<10	<10	100	100	100	100	10	10	10	10	10	10	10	10
354	<10	<10	10	10	100	100	100	100	10	10	10	10	10	10	10	10

(continued)

TABLE A-13 (continued)

Participant I.D.	Coxsackievirus B-1*				Poliovirus Type 1†				Poliovirus Type 2†				Poliovirus Type 3†			
	Period				Period				Period				Period			
	1	2	4	5	1	2	4	5	1	2	4	5	1	2	4	5
355	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
356	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
359	10	10	NSC	<10	100	100	NSC	100	100	100	NSC	100	100	100	NSC	100
361	<10	<10	<10	<10	10	10	10	10	100	100	100	100	100	100	100	100
362	<10	<10	<10	NSC	<10	<10	<10	NSC	100	100	100	NSC	100	100	100	NSC
363	NSC	NSC	<10	<10	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC	100	100
364	<10	<10	<10	<10	100	100	100	100	100	100	100	100	10	10	10	10
365	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
366	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
367	20	20	10	<10	100	100	100	100	100	100	100	100	100	100	100	100
368	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
370	<10	<10	<10	<10	100	100	100	100	10	10	10	10	100	100	100	100
372	<10	<10	<10	<10	10	10	10	10	100	100	100	100	10	10	10	10
373	NSC	NSC	<10	<10	NSC	NSC	100	100	NSC	NSC	10	10	NSC	NSC	100	100
374	<10	<10	<10	<10	10	10	10	10	10	10	10	10	10	10	10	10
375	NSC	NSC	<10	<10	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC	100	100
378	<10	NSC	NSC	<10	100	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC	100
383	<10	NSC	NSC	NSC	100	NSC	NSC	NSC	100	NSC	NSC	NSC	100	NSC	NSC	NSC
384	<10	NSC	NSC	NSC	100	NSC	NSC	NSC	100	NSC	NSC	NSC	100	NSC	NSC	NSC
385	<10	<10	NSC	<10	100	100	NSC	100	100	100	100	100	100	100	NSC	100
386	<10	<10	<10	<10	100	100	100	100	100	100	100	100	10	10	10	10
387	<10	<10	<10	<10	10	10	10	10	100	100	100	100	10	10	10	10
388	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
390	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
391	<10	<10	<10	<10	10	10	10	10	10	10	10	10	10	10	10	10
392	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
393	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
394	<10	<10	<10	NSC	100	100	100	NSC	10	10	10	NSC	10	10	10	NSC
395	<10	<10	<10	NSC	10	10	10	NSC	10	10	10	NSC	10	10	10	NSC
396	<10	<10	<10	NSC	100	100	100	NSC	100	100	100	NSC	100	100	100	NSC
397	<10	<10	<10	NSC	100	100	100	NSC	100	100	100	NSC	100	100	100	NSC
398	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
399	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
400	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
402	<10	<10	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC
403	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
405	10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
406	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
407	10	<10	10	10	10	<10	10	10	10	10	10	10	10	10	10	10
408	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
412	10	<10	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC
413	<10	<10	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC
414	NSC	NSC	10	10	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC	100	100
415	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
416	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
417	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
418	<10	<10	<10	<10	10	10	10	10	10	10	10	10	10	10	10	10

(continued)

TABLE A-13 (continued)

Participant I.D.	Coxsackievirus B-1*				Poliovirus Type 1*				Poliovirus Type 2*				Poliovirus Type 3*			
	Period				Period				Period				Period			
	1	2	4	5	1	2	4	5	1	2	4	5	1	2	4	5
419	<10	<10	<10	<10	10	10	10	10	10	10	10	10	10	10	10	10
421	<10	<10	<10	<10	100	100	100	100	10	10	10	10	100	100	100	100
422	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
423	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
424	<10	<10	<10	<10	10	10	10	10	10	10	10	10	10	10	10	10
426	<10	<10	<10	<10	10	10	10	10	10	10	10	10	10	10	10	10
428	<10	<10	<10	<10	10	10	10	10	10	10	10	10	10	10	10	10
429	<10	<10	<10	<10	100	100	100	100	10	10	10	10	10	10	10	10
430	NSC	<10	<10	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC	100	100	NSC
438	<10	<10	NSC	NSC	10	10	NSC	NSC	10	10	NSC	NSC	10	10	NSC	NSC
441	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
442	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
443	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
445	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
446	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
449	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
450	<10	NSC	<10	<10	100	NSC	100	100	100	NSC	100	100	100	NSC	100	100
451	<10	<10	<10	<10	100	100	100	100	100	100	100	100	10	10	10	10
452	<10	<10	<10	NSC	100	100	100	NSC	10	10	10	NSC	10	10	10	NSC
453	10	10	10	NSC	100	10	100	NSC	100	100	100	NSC	100	100	100	NSC
454	<10	<10	<10	NSC	100	100	100	NSC	100	100	100	NSC	100	100	100	NSC
455	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
457	<10	<10	<10	<10	100	100	100	100	10	01	10	10	10	10	10	10
458	<10	<10	<10	<10	<10	<10	10	10	10	10	10	10	10	10	10	10
459	20	20	10	10	10	10	10	100	100	100	100	100	10	10	10	10
460	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
461	<10	<10	NSC	<10	100	100	NSC	100	100	100	100	100	100	100	NSC	100
464	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
465	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
466	<10	<10	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC
467	<10	<10	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC
500	<10	NSC	<10	<10	100	NSC	NSC	NSC	10	NSC	10	10	10	NSC	10	10
501	<10	NSC	NSC	NSC	100	NSC	NSC	NSC	100	NSC	NSC	NSC	100	NSC	NSC	NSC
502	<10	<10	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC
503	<10	<10	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC
504	<10	<10	<10	<10	100	100	NSC	NSC	100	100	100	100	100	100	100	100
505	NSC	NSC	<10	<10	NSC	NSC	100	100	NSC	NSC	100	100	NSC	NSC	100	100
506	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
507	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
508	<10	<10	<10	<10	100	100	100	100	100	100	100	100	100	100	100	100
509	<10	<10	<10	<10	10	10	10	10	10	10	10	10	10	10	10	10
510	<10	<10	<10	<10	100	100	100	100	10	10	10	10	10	10	10	10
512	NSC	<10	<10	<10	NSC	100	100	100	NSC	100	100	100	NSC	100	100	100

(continued)

TABLE A-13 (continued)

Participant I.D.	Coxsackievirus B-1*		Poliovirus Type 1†		Poliovirus Type 2†		Poliovirus Type 3†	
	Period		Period		Period		Period	
	3	5	3	5	3	5	3	5
600	<10	20	100	100	100	100	100	100
601	<10	<10	100	100	100	100	100	100
602	<10	<10	100	100	100	100	100	100
603	<10	<10	100	100	10	10	100	100
614	<10	<10	100	100	100	100	100	100
615	<10	<10	10	10	10	10	10	10
616	<10	<10	10	10	10	10	10	10
617	<10	<10	10	10	10	10	10	10
619	<10	<10	100	100	10	10	100	100
621	<10	<10	<10	<10	<10	<10	<10	<10
622	NSC	<10	NSC	10	NSC	NSC	NSC	100
623	NSC	<10	NSC	10	NSC	NSC	NSC	100
628	<10	<10	10	10	100	100	100	100
629	NSC	<10	NSC	10	NSC	NSC	NSC	100
630	<10	<10	100	100	100	100	100	100
631	<10	<10	10	10	10	10	10	10
632	<10	<10	100	100	100	100	100	100
633	<10	<10	100	100	100	100	100	100
634	<10	<10	100	100	100	100	100	100
640	20	20	100	10	100	100	100	100
641	10	10	100	100	10	10	100	100
642	<10	<10	10	100	100	100	100	100
643	<10	<10	100	100	10	10	100	100
644	<10	<10	10	10	100	100	10	10
645	<10	<10	10	10	10	10	10	10
646	<10	<10	100	100	100	100	100	100
647	<10	<10	100	100	100	100	100	100
648	<10	<10	10	10	100	10	100	100
649	NSC	NSC	100	100	<10	<10	10	10
650	NSC	NSC	100	100	100	100	100	100
651	NSC	NSC	100	100	100	100	100	100
652	<10	<10	10	10	100	100	100	100
653	<10	<10	100	10	100	100	100	100
654	<10	<10	10	10	100	100	100	100

*by Hemagglutination Inhibition
†by Serum Neutralization

TABLE A-14 ECHOVIRUS ANTIBODY TITERS BY HEMAGGLUTINATION INHIBITION FROM ALL INDIVIDUAL PARTICIPANTS

Participant	Echovirus 3				Echovirus 7				Echovirus 11				Echovirus 12			
	Period				Period				Period				Period			
I. D.	1	2	4	5	1	2	4	5	1	2	4	5	1	2	4	5
1	80	<10	20	NSC	10	<10	10	NSC	<10	<10	<10	NSC	<10	<10	10	NSC
2	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10
3	10	NSC	U	<10	10	NSC	U	<10	<10	NSC	U	<10	<10	NSC	U	<10
4	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
5	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
6	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
9	20	<10	NSC	<10	10	<10	NSC	<10	<10	<10	NSC	<10	20	10	NSC	10
10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
11	<10	<10	<10	20	40	20	20	40	<10	<10	<10	<10	40	10	20	20
12	U	80	U	U	U	10	U	U	U	10	U	U	U	10	U	U
13	160	<10	160	160	80	10	10	20	80	40	40	160	40	10	10	10
14	80	80	40	20	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
15	40	160	160	160	20	20	20	20	80	80	160	160	<10	10	10	20
16	10	20	10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10	10	<10	<10
18	<10	<10	10	<10	10	<10	40	10	<10	<10	10	<10	<10	<10	<10	<10
19	<10	10	<10	<10	<10	10	10	10	<10	<10	<10	<10	<10	<10	<10	<10
29	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
30	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
31	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
32	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
33	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
49	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	<10	10
50	10	20	20	40	10	<10	<10	<10	<10	10	<10	20	20	<10	<10	10
74	80	20	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	20	10	10	<10
75	<10	<10	<10	<10	20	20	10	20	<10	<10	20	<10	<10	<10	<10	<10
76	<10	<10	<10	<10	10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10
77	10	<10	<10	NSC	20	10	10	NSC	20	<10	20	NSC	<10	<10	<10	NSC
78	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
83	160	>320	>320	40	160	80	40	40	160	80	40	20	160	160	40	40
84	10	160	10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
97	10	<10	<10	20	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
98	NSC	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10
99	10	10	10	10	<10	<10	<10	<10	10	10	10	10	<10	10	10	<10
100	<10	<10	<10	10	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10
101	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
102	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
103	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
113	10	20	NSC	NSC	<10	10	NSC	NSC	<10	<10	NSC	NSC	<10	10	NSC	NSC
114	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC
115	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC
116	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC
117	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC

(continued)

TABLE A-14 (continued)

Participant	Echovirus 3				Echovirus 7				Echovirus 11				Echovirus 12			
	Period				Period				Period				Period			
I.D.	1	2	4	5	1	2	4	5	1	2	4	5	1	2	4	5
131	<10	10	<10	NSC	<10	<10	<10	NSC	<10	10	<10	NSC	<10	<10	<10	<10
141	20	20	20	40	10	10	10	10	10	10	10	10	<10	10	10	10
142	10	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10	<10
143	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
144	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
145	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
146	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
157	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
158	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
159	<10	<10	10	<10	<10	<10	<10	<10	10	<10	<10	<10	10	<10	<10	<10
160	NSC	<10	<10	10	NSC	<10	<10	<10	NSC	<10	<10	<10	<10	<10	<10	<10
162	10	20	20	40	<10	10	10	10	<10	<10	<10	<10	<10	10	10	10
165	<10	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	10	10	<10	<10
166	<10	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
167	<10	NSC	NSC	NSC	NSC	NSC	NSC	NSC	<10	NSC	NSC	NSC	<10	NSC	NSC	NSC
171	NSC	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	<10	<10	<10	<10
172	<10	10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
177	<10	20	10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	<10	<10
178	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
179	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10
180	<10	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10	<10	<10	<10	<10
181	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
182	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
183	NSC	<10	<10	<10	NSC	<10	NSC	<10	NSC	<10	NSC	<10	<10	<10	<10	<10
189	40	20	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	10	10	NSC	NSC
190	10	20	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC
191	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC
192	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC
193	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC
194	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	10	NSC	NSC
195	NSC	<10	NSC	NSC	NSC	<10	NSC	NSC	NSC	<10	NSC	NSC	<10	<10	NSC	NSC
196	20	10	10	10	10	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10
198	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	<10
199	10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
201	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC
202	NSC	<10	NSC	NSC	NSC	<10	NSC	NSC	NSC	<10	NSC	NSC	<10	<10	NSC	NSC
206	80	40	20	40	10	10	<10	<10	20	10	10	10	20	20	10	10
207	10	<10	<10	<10	<10	10	10	10	<10	<10	<10	<10	<10	<10	<10	<10
208	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
209	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
213	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
214	<10	10	10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
226	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	10	<10	10

(continued)

TABLE A-14 (continued)

Participant I. D.	Echovirus 3				Echovirus 7				Echovirus 11				Echovirus 12			
	Period				Period				Period				Period			
	1	2	4	5	1	2	4	5	1	2	4	5	1	2	4	5
227	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10	<10	<10
228	<10	10	10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
229	40	10	10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
230	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	10	NSC	NSC	<10	<10	<10	<10
231	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	<10	10	10
232	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	<10	<10	<10	<10
233	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
235	NSC	NSC	NSC	20	NSC	NSC	NSC	10	NSC	NSC	NSC	<10	<10	<10	<10	<10
241	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
242	10	20	20	20	<10	<10	<10	<10	<10	<10	10	10	<10	10	<10	10
243	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
244	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
254	<10	NSC	NSC	NSC	<10	NSC	NSC	NSC	<10	NSC	NSC	NSC	<10	<10	NSC	NSC
255	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	<10
256	10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	10	<10
257	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	<10	<10	<10	<10
258	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	<10
260	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
262	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
263	<10	<10	<10	<10	10	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10
266	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	<10
267	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
268	10	20	20	20	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	10	10
273	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
275	<10	<10	<10	<10	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10
276	10	10	10	20	<10	<10	<10	<10	10	10	10	80	<10	<10	<10	20
278	<10	10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
284	<10	<10	<10	<10	20	10	10	10	<10	<10	<10	<10	<10	<10	<10	<10
290	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
293	<10	<10	NSC	NSC	<10	10	NSC	NSC	<10	10	NSC	NSC	10	10	NSC	NSC
294	<10	<10	10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
302	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
303	NSC	10	10	20	NSC	10	10	20	NSC	<10	<10	<10	<10	10	<10	10
312	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
313	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
314	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	10	<10
315	NSC	<10	<10	<10	NSC	<10	<10	10	NSC	<10	10	<10	<10	<10	<10	<10
316	10	10	20	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
324	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
325	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
330	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
334	<10	10	10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

(continued)

TABLE A-14 (continued)

Participant I.D.	Echovirus 3				Echovirus 7				Echovirus 11				Echovirus 12			
	Period				Period				Period				Period			
	1	2	4	5	1	2	4	5	1	2	4	5	1	2	4	5
335	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
336	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	10	<10	<10
337	<10	<10	10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
338	<10	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
339	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
340	NSC	NSC	NSC	<10	NSC	NSC	NSC	<10	NSC	NSC	NSC	<10	<10	<10	<10	<10
341	NSC	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	<10	<10	<10	<10
342	NSC	<10	NSC	NSC	NSC	<10	NSC	NSC	NSC	<10	NSC	NSC	<10	<10	<10	<10
343	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
348	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	<10	<10	<10
349	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
350	40	40	40	80	<10	10	10	20	<10	10	<10	20	10	10	10	20
353	40	20	20	20	<10	<10	<10	<10	<10	<10	<10	<10	20	10	10	10
354	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
355	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10
356	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
359	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	10	<10	<10	<10
361	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
362	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	<10
363	NSC	NSC	10	<10	NSC	NSC	<10	<10	NSC	NSC	NSC	<10	<10	<10	<10	<10
364	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10	<10
365	<10	10	10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
366	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
367	80	20	20	20	10	<10	<10	<10	20	10	10	<10	20	10	10	<10
368	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
370	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
372	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
373	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	<10	<10	<10	<10
374	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
375	NSC	NSC	10	20	NSC	NSC	<10	<10	NSC	NSC	<10	<10	<10	<10	<10	<10
378	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	<10	<10	<10
383	<10	NSC	NSC	NSC	<10	NSC	NSC	NSC	<10	NSC	NSC	NSC	<10	NSC	NSC	NSC
384	10	NSC	NSC	NSC	<10	NSC	NSC	NSC	<10	NSC	NSC	NSC	<10	NSC	NSC	NSC
385	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	<10	<10
386	<10	<10	<10	<10	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10
387	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
388	80	20	40	40	<10	<10	<10	<10	10	<10	10	10	20	10	10	10
390	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
391	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
392	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
393	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	<10	<10
394	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	<10
395	20	20	10	NSC	<10	<10	10	NSC	<10	40	<10	NSC	10	10	<10	<10

(continued)

TABLE A-14 (continued)

Participant I. D.	Echovirus 3				Echovirus 7				Echovirus 11				Echovirus 12			
	Period				Period				Period				Period			
	1	2	4	5	1	2	4	5	1	2	4	5	1	2	4	5
396	10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	<10
397	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	<10
398	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
399	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
400	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
402	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC
403	160	40	80	80	<10	<10	<10	<10	40	20	10	10	20	20	10	10
405	<10	<10	10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
406	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
407	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
408	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
412	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC
413	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC
414	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	<10	<10	<10	<10
415	20	10	10	20	<10	<10	<10	10	10	<10	<10	<10	10	<10	<10	<10
416	<10	10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
417	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
418	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
419	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10	<10	<10
421	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	10
422	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
423	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
424	<10	<10	<10	<10	<10	<10	<10	10	<10	10	<10	<10	<10	<10	<10	<10
426	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
428	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
429	<10	<10	<10	10	<10	<10	<10	<10	<10	10	10	<10	<10	<10	<10	<10
430	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	<10	10	<10	<10
438	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC
441	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
442	<10	<10	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
443	20	10	10	10	<10	<10	<10	<10	<10	<10	<10	<10	10	10	<10	10
445	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
446	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
449	<10	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	10	10	10	<10
450	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	10	<10	<10	<10	<10
451	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
452	<10	10	<10	NSC	<10	<10	10	NSC	<10	<10	<10	NSC	<10	<10	<10	<10
453	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	<10
454	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	<10
455	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
457	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
458	<10	10	10	<10	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10	<10

(continued)

TABLE A-14 (continued)

Participant I.D.	Echovirus 3				Echovirus 7				Echovirus 11				Echovirus 12			
	Period				Period				Period				Period			
	1	2	4	5	1	2	4	5	1	2	4	5	1	2	4	5
459	80	80	80	160	<10	10	10	20	10	<10	<10	20	20	10	10	20
460	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10
461	<10	<10	NSC	<10	<10	<10	NSC	10	<10	10	NSC	<10	<10	40	<10	<10
464	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
465	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
466	10	10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	<10	<10
467	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	<10	<10
500	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10	<10	<10	<10
501	<10	NSC	NSC	NSC	<10	NSC	NSC	NSC	<10	NSC	NSC	NSC	<10	10	NSC	NSC
502	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC
503	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC
504	<10	<10	<10	<10	<10	<10	<10	NSC	<10	<10	<10	<10	<10	<10	<10	<10
505	NSC	NSC	10	20	NSC	NSC	<10	<10	NSC	NSC	<10	<10	NSC	NSC	10	10
506	<10	<10	40	40	<10	<10	<10	10	<10	<10	10	<10	<10	<10	10	10
507	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
508	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
509	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
510	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10
512	NSC	<10	<10	10	NSC	<10	<10	<10	NSC	<10	<10	<10	NSC	<10	<10	<10

TABLE A-15 ADENOVIRUS ANTIBODY TITERS BY SERUM NEUTRALIZATION FROM 100 INDIVIDUAL PARTICIPANTS

Participant I.D.	Adenovirus 1 Period		Adenovirus 2 Period		Adenovirus 3 Period		Adenovirus 4 Period		Adenovirus 5 Period	
	1	5	1	5	1	5	1	5	1	5
2	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
3	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
4	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
11	<10	<10	<10	<10	<10	<10	<10	10	<10	<10
12	<10	<10	<10	10	<10	<10	<10	<10	<10	<10
13	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
14	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
15	<10	<10	<10	<10	<10	<10	<10	<10	<10	10
16	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
29	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
33	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
49	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
50	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
74	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
75	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
76	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
83	<10	<10	<10	<10	<10	<10	<10	10	10	10
84	<10	<10	10	10	<10	10	<10	<10	10	10
97	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
101	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
102	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
141	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
143	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
145	10	10	<10	<10	<10	<10	<10	10	<10	<10
146	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
157	<10	<10	<10	<10	<10	10	<10	<10	<10	<10
158	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
159	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
162	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
165	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
166	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
172	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
177	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
178	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
181	<10	10	<10	<10	<10	<10	<10	<10	10	10
182	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
196	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
199	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
206	<10	<10	<10	<10	<10	10	<10	<10	<10	<10
207	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
213	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
214	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
226	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
227	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
228	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
229	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
231	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
233	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
241	<10	<10	10	10	<10	10	<10	<10	10	10
242	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
244	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
260	<10	<10	<10	<10	<10	<10	<10	<10	<10	10
284	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

(continued)

TABLE A-15 (continued)

Participant I.D.	Adenovirus 1		Adenovirus 2		Adenovirus 3		Adenovirus 4		Adenovirus 5	
	Period		Period		Period		Period		Period	
	1	5	1	5	1	5	1	5	1	5
290	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
294	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
312	<10	<10	<10	<10	<10	10	<10	<10	<10	<10
324	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
325	<10	<10	<10	<10	<10	<10	<10	10	<10	<10
372	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
374	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
386	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
391	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
441	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
443	<10	10	<10	<10	10	10	<10	<10	<10	<10
445	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
446	<10	<10	<10	<10	<10	<10	<10	<10	<10	10
457	<10	<10	10	<10	<10	<10	<10	<10	<10	<10
464	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
465	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
500	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
504	<10	<10	<10	<10	<10	<10	<10	<10	10	<10
510	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	Period		Period		Period		Period		Period	
	3	5	3	5	3	5	3	5	3	5
603	10	<10	10	<10	<10	<10	<10	<10	<10	<10
614	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
615	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
616	10	10	10	<10	10	10	<10	10	<10	<10
617	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
619	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
621	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
628	<10	<10	<10	<10	<10	10	<10	<10	<10	<10
630	<10	10	<10	<10	<10	<10	<10	10	<10	<10
631	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
632	<10	10	<10	<10	<10	<10	<10	<10	<10	<10
633	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
634	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
640	<10	<10	<10	<10	<10	<10	<10	<10	<10	10
641	<10	<10	<10	<10	<10	<10	10	<10	<10	<10
642	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
643	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
644	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
645	<10	10	10	10	<10	<10	<10	<10	<10	<10
646	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
647	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
648	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
649	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
650	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
651	<10	<10	<10	<10	<10	<10	<10	10	<10	<10
652	<10	<10	<10	<10	10	<10	<10	<10	<10	<10
653	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
654	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

TABLE A-16 COXSACKIEVIRUS ANTIBODY TITERS FROM 100 INDIVIDUAL PARTICIPANTS

Participant I.D.	Coxsackievirus A-7† Period		Coxsackievirus A-9† Period		Coxsackievirus A-16† Period		Coxsackievirus B-3* Period		Coxsackievirus B-5* Period		Coxsackievirus B-6* Period	
	1	5	1	5	1	5	1	5	1	5	1	5
2	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
3	<10	<10	<10	<10	<10	<10	<10	<10	<10	20	<10	<10
4	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	<10	<10
11	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	<10	<10
12	<10	<10	<10	<10	<10	<10	10	10	10	<10	<10	<10
13	<10	10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10
14	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	20
15	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
16	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
29	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
33	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
49	<10	20	<10	<10	<10	<10	<10	10	10	10	<10	<10
50	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
74	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
75	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
76	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
83	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
84	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
97	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
101	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10
102	<10	<10	10	10	10	10	10	<10	<10	<10	<10	<10
141	<10	<10	<10	<10	<10	10	<10	<10	<10	<10	<10	<10
143	<10	<10	10	10	10	10	<10	<10	<10	<10	<10	<10
145	<10	<10	<10	<10	<10	<10	20	20	10	<10	10	10
146	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
157	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
158	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
159	10	10	<10	<10	<10	<10	<10	20	10	10	<10	<10
162	<10	<10	<10	<10	<10	<10	<10	<10	20	10	<10	<10
165	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
166	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
172	<10	<10	<10	<10	<10	<10	10	10	<10	<10	10	10
177	<10	<10	<10	<10	<10	10	<10	<10	<10	<10	<10	<10
178	<10	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10
181	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
182	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
196	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
199	<10	10	<10	<10	<10	10	<10	<10	<10	<10	<10	<10
206	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	<10	<10
207	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
213	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
214	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
226	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
227	<10	<10	<10	<10	<10	10	<10	<10	<10	<10	<10	<10
228	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
229	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
231	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
233	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
241	10	10	<10	<10	<10	<10	<10	10	<10	10	<10	<10
242	10	10	10	10	<10	<10	<10	<10	<10	<10	<10	<10
244	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
260	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10	<10
284	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
290	<10	<10	<10	<10	<10	<10	10	10	<10	40	<10	<10

(continued)

TABLE A-16 (continued)

Participant I.D.	Coxsackievirus A-7†		Coxsackievirus A-9†		Coxsackievirus A-16†		Coxsackievirus B-3*		Coxsackievirus B-5*		Coxsackievirus B-6*	
	Period		Period		Period		Period		Period		Period	
	1	5	1	5	1	5	1	5	1	5	1	5
294	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
312	80	10	<10	<10	<10	<10	10	<10	<10	<10	<10	<10
324	10	10	10	10	10	10	<10	<10	<10	<10	<10	<10
325	10	10	10	10	<10	<10	<10	<10	<10	<10	<10	<10
372	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
374	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10	<10
386	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
391	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	<10	<10
441	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10
443	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
445	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
446	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
457	<10	<10	<10	<10	<10	<10	10	<10	<10	<10	<10	<10
464	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
465	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
500	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
504	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
510	<10	10	10	10	<10	<10	<10	<10	<10	<10	<10	<10
	Period		Period		Period		Period		Period		Period	
	3	5	3	5	3	5	3	5	3	5	3	5
603	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
614	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
615	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
616	<10	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10
617	<10	10	10	10	<10	<10	10	10	<10	<10	<10	<10
619	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
621	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
628	<10	<10	<10	10	<10	<10	<10	10	<10	<10	<10	<10
630	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	10
631	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
632	<10	20	<10	10	<10	10	20	20	10	<10	<10	<10
633	<10	20	<10	10	<10	<10	<10	<10	<10	<10	20	10
634	10	<10	<10	<10	<10	<10	10	<10	<10	10	<10	<10
640	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
641	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
642	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
643	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
644	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
645	10	10	<10	<10	<10	10	<10	10	<10	<10	<10	<10
646	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
647	10	10	<10	10	<10	<10	<10	<10	<10	<10	10	10
648	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	<10
649	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
650	<10	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10
651	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
652	<10	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10
653	<10	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10
654	10	20	10	10	10	10	10	10	10	<10	<10	<10

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*by Hemagglutination Inhibition
†by Serum Neutralization

TABLE A-17 ECHOVIRUS ANTIBODY TITERS BY SERUM NEUTRALIZATION FROM 100 INDIVIDUAL PARTICIPANTS

Participant I.D.	Echovirus 4		Echovirus 8		Echovirus 33	
	Period		Period		Period	
	1	5	1	5	1	5
2	<10	<10	<10	<10	<10	<10
3	<10	10	<10	<10	<10	<10
4	<10	<10	<10	<10	<10	<10
11	<10	<10	<10	<10	<10	<10
12	<10	<10	<10	<10	<10	<10
13	40	20	10	20	20	20
14	20	20	10	<10	20	20
15	20	20	10	20	20	10
16	10	10	<10	<10	<10	10
29	<10	<10	<10	<10	<10	<10
33	<10	<10	<10	<10	<10	<10
49	<10	<10	<10	<10	<10	<10
50	<10	<10	<10	<10	<10	<10
74	10	<10	<10	<10	<10	<10
75	<10	<10	<10	<10	<10	<10
76	<10	<10	<10	<10	<10	<10
83	40	40	<10	<10	20	20
84	<10	<10	<10	<10	<10	<10
97	<10	<10	10	10	<10	<10
101	<10	<10	<10	<10	<10	<10
102	<10	<10	<10	<10	<10	<10
141	10	10	10	<10	10	10
143	<10	<10	<10	<10	<10	<10
145	<10	<10	<10	<10	<10	<10
146	<10	<10	<10	<10	<10	<10
157	<10	<10	10	<10	<10	<10
158	<10	<10	<10	<10	<10	<10
159	<10	<10	<10	<10	<10	<10
162	<10	<10	<10	<10	<10	<10
165	<10	<10	<10	<10	<10	<10
166	<10	10	<10	<10	<10	<10
172	<10	<10	<10	<10	<10	<10
177	<10	<10	<10	<10	<10	<10
178	<10	<10	<10	<10	<10	<10
181	<10	<10	<10	<10	<10	<10
182	<10	<10	<10	<10	<10	<10
196	<10	<10	<10	<10	<10	<10
199	<10	<10	<10	<10	<10	<10
206	10	40	10	<10	10	20
207	<10	<10	<10	<10	<10	<10
213	<10	<10	<10	<10	<10	<10
214	<10	<10	<10	<10	<10	<10
226	<10	<10	<10	<10	<10	<10
227	<10	<10	<10	<10	<10	<10
228	<10	<10	<10	<10	<10	<10
229	<10	<10	<10	<10	<10	<10
231	<10	<10	<10	<10	<10	<10
233	10	10	<10	<10	<10	10
241	<10	<10	<10	<10	<10	<10
242	<10	<10	<10	<10	<10	<10
244	<10	<10	<10	<10	<10	<10
260	<10	<10	<10	<10	<10	<10

(continued)

TABLE A-17 (continued)

Participant I.D.	Echovirus 4 Period 1	Echovirus 4 Period 5	Echovirus 8 Period 1	Echovirus 8 Period 5	Echovirus 33 Period 1	Echovirus 33 Period 5
284	<10	<10	<10	<10	<10	<10
290	<10	<10	<10	<10	<10	<10
294	<10	<10	<10	<10	<10	<10
312	<10	<10	<10	<10	<10	<10
324	<10	<10	<10	<10	<10	<10
325	<10	<10	<10	<10	<10	<10
372	<10	20	<10	<10	<10	<10
374	<10	<10	<10	<10	<10	<10
386	<10	<10	<10	<10	<10	<10
391	<10	10	<10	<10	<10	<10
441	<10	<10	<10	<10	<10	<10
443	<10	<10	<10	<10	<10	<10
445	20	10	<10	<10	<10	<10
446	<10	<10	<10	<10	10	<10
457	<10	<10	<10	<10	<10	<10
464	<10	<10	<10	<10	<10	<10
465	10	10	<10	<10	<10	<10
500	<10	<10	<10	<10	10	<10
504	<10	<10	<10	<10	<10	<10
510	<10	<10	<10	<10	<10	<10

	Period 3	Period 5	Period 3	Period 5	Period 3	Period 5
603	<10	<10	<10	<10	<10	<10
614	<10	<10	<10	<10	<10	<10
615	<10	<10	<10	<10	<10	<10
616	<10	<10	<10	<10	<10	<10
617	<10	<10	<10	<10	<10	10
619	<10	<10	<10	<10	<10	<10
621	<10	<10	<10	<10	<10	<10
628	<10	<10	<10	<10	<10	<10
630	<10	<10	<10	<10	<10	<10
631	<10	10	<10	<10	<10	<10
632	<10	<10	<10	<10	<10	<10
633	10	<10	<10	<10	<10	<10
634	10	10	10	10	10	10
640	<10	<10	<10	<10	<10	<10
641	<10	<10	<10	<10	<10	<10
642	<10	<10	<10	<10	<10	<10
643	<10	<10	<10	<10	<10	<10
644	<10	<10	<10	<10	<10	<10
645	<10	<10	<10	<10	<10	<10
646	<10	<10	<10	<10	<10	<10
647	<10	<10	<10	<10	<10	<10
648	<10	<10	<10	<10	<10	<10
649	<10	<10	<10	<10	<10	<10
650	<10	<10	<10	<10	<10	<10
651	20	10	10	10	10	10
652	<10	<10	<10	<10	<10	<10
653	<10	<10	<10	<10	<10	<10
654	<10	<10	<10	<10	<10	<10

TABLE A-18 ECHOVIRUS ANTIBODY TITERS BY HEMAGGLUTINATION INHIBITION FROM 100 INDIVIDUAL PARTICIPANTS

Participant I.D.	Echovirus 6		Echovirus 13		Echovirus 19		Echovirus 21		Echovirus 25		Echovirus 29	
	Period		Period		Period		Period		Period		Period	
	1	5	1	5	1	5	1	5	1	5	1	5
2	<10	<10	<10	<10	<10	<10	<10	10	10	10	10	10
3	10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10
4	10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
11	<10	<10	10	10	<10	<10	<10	<10	<10	<10	<10	10
12	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10	10
13	10	10	<10	20	10	10	<10	<10	<10	<10	<10	<10
14	10	10	<10	<10	10	<10	<10	<10	<10	<10	<10	<10
15	10	10	<10	20	<10	10	<10	<10	<10	<10	<10	<10
16	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
29	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
33	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
49	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
50	<10	10	<10	<10	<10	10	<10	<10	<10	<10	<10	<10
74	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
75	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
76	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
83	20	<10	20	10	10	10	<10	<10	<10	<10	<10	<10
84	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
97	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
101	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
102	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
141	<10	<10	10	40	<10	<10	<10	<10	<10	<10	<10	<10
143	<10	<10	<10	<10	<10	<10	10	10	<10	<10	10	10
145	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
146	10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
157	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
158	<10	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10
159	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
162	<10	10	<10	<10	<10	10	<10	<10	<10	<10	<10	<10
165	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
166	<10	<10	<10	<10	<10	10	<10	<10	<10	<10	<10	<10
172	<10	<10	<10	<10	<10	<10	<10	<10	10	10	<10	<10
177	<10	40	<10	<10	<10	<10	10	10	10	10	<10	10
178	<10	<10	10	10	<10	<10	<10	<10	<10	<10	<10	<10
181	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
182	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
196	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
199	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
206	<10	10	<10	<10	10	<10	<10	<10	<10	<10	<10	<10
207	<10	<10	<10	<10	<10	<10	<10	<10	< 10	<10	<10	<10
213	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10	10
214	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
226	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
227	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
228	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
229	10	<10	<10	<10	10	10	<10	<10	<10	<10	<10	<10
231	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
233	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
241	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
242	<10	<10	<10	<10	<10	10	<10	10	10	<10	<10	20
244	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10	20
260	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

(continued)

TABLE A-18 (continued)

Participant I.D.	Echovirus 6		Echovirus 13		Echovirus 19		Echovirus 21		Echovirus 25		Echovirus 29	
	Period		Period		Period		Period		Period		Period	
	1	5	1	5	1	5	1	5	1	5	1	5
284	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
290	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
294	<10	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10
312	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10	<10
324	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	10
325	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10	10
372	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	20
374	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
386	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10
391	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
441	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	<10
443	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
445	<10	<10	10	10	<10	<10	<10	<10	<10	<10	<10	<10
446	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
457	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
464	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
465	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
500	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
504	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	<10
510	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

	Period		Period		Period		Period		Period		Period	
	3	5	3	5	3	5	3	5	3	5	3	5
603	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
614	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
615	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
616	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10	<10
617	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
619	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
621	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10
628	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
630	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	<10
631	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
632	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
633	10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
634	10	10	10	<10	10	10	<10	<10	10	10	<10	<10
640	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
641	<10	<10	<10	<10	<10	<10	10	10	<10	<10	10	10
642	<10	<10	<10	<10	<10	<10	<10	10	10	10	10	10
643	<10	<10	<10	<10	<10	<10	<10	10	10	10	10	10
644	<10	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10
645	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
646	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
647	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
648	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
649	<10	<10	<10	<10	<10	<10	<10	<10	10	10	<10	<10
650	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
651	10	<10	10	<10	10	10	<10	10	<10	10	<10	<10
652	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
653	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
654	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

TABLE A-19 REOVIRUS ANTIBODY TITERS BY HEMAGGLUTINATION INHIBITION FROM 100 INDIVIDUAL PARTICIPANTS

Participant I.D.	Reovirus 1 Period 1	Reovirus 1 Period 5	Reovirus 2 Period 1	Reovirus 2 Period 5	Reovirus 3 Period 1	Reovirus 3 Period 5
2	<10	<10	<10	<10	<10	<10
3	<10	<10	<10	<10	<10	<10
4	<10	<10	<10	<10	<10	<10
11	<10	<10	<10	<10	<10	<10
12	<10	<10	<10	<10	<10	<10
13	<10	<10	<10	<10	<10	<10
14	<10	<10	<10	<10	<10	<10
15	<10	<10	<10	<10	<10	<10
16	<10	<10	<10	<10	<10	<10
29	<10	<10	<10	<10	<10	<10
33	<10	<10	<10	<10	<10	<10
49	<10	<10	<10	<10	<10	<10
50	<10	<10	<10	<10	<10	<10
74	<10	<10	<10	<10	<10	<10
75	<10	<10	<10	<10	<10	<10
76	<10	<10	<10	<10	<10	<10
83	<10	<10	<10	<10	<10	<10
84	<10	<10	<10	<10	<10	<10
97	<10	<10	<10	<10	<10	<10
101	<10	<10	<10	<10	<10	<10
102	<10	<10	<10	<10	<10	<10
141	<10	<10	<10	<10	<10	<10
143	<10	<10	<10	<10	<10	<10
145	<10	<10	<10	<10	<10	<10
146	<10	<10	<10	<10	<10	<10
157	<10	<10	<10	<10	<10	<10
158	<10	<10	<10	<10	<10	<10
159	<10	<10	<10	<10	<10	<10
162	<10	<10	<10	<10	<10	<10
165	<10	<10	<10	<10	<10	<10
166	<10	<10	<10	<10	<10	<10
172	<10	<10	<10	<10	<10	<10
177	<10	<10	<10	<10	<10	<10
178	<10	<10	<10	<10	<10	<10
181	<10	<10	<10	<10	<10	10
182	<10	<10	<10	<10	<10	10
196	<10	<10	<10	<10	<10	<10
199	<10	<10	<10	<10	<10	<10
206	<10	<10	<10	<10	<10	<10
207	<10	<10	<10	<10	<10	<10
213	<10	<10	<10	<10	<10	<10
214	<10	<10	<10	<10	<10	<10
226	<10	<10	<10	<10	<10	<10
227	<10	<10	<10	<10	<10	<10
228	<10	<10	<10	<10	<10	<10
229	<10	<10	<10	<10	<10	<10
231	<10	<10	<10	<10	<10	<10
233	<10	<10	<10	<10	<10	<10
241	<10	<10	<10	<10	<10	<10
242	<10	<10	<10	<10	<10	<10
244	<10	<10	<10	<10	<10	<10
260	<10	<10	<10	<10	<10	<10
284	<10	<10	<10	<10	<10	<10

(continued)

TABLE A-19 (continued)

Participant I.D.	Reovirus 1		Reovirus 2		Reovirus 3	
	Period		Period		Period	
	1	5	1	5	1	5
290	<10	10	<10	<10	<10	<10
294	<10	<10	<10	<10	<10	<10
312	<10	<10	<10	<10	<10	<10
324	<10	<10	<10	<10	<10	<10
325	<10	<10	<10	<10	<10	<10
372	<10	<10	<10	<10	<10	<10
374	<10	<10	<10	<10	<10	<10
386	<10	<10	<10	<10	<10	<10
391	<10	<10	<10	<10	<10	<10
441	<10	<10	<10	<10	<10	<10
443	<10	<10	<10	<10	<10	<10
445	<10	<10	<10	<10	<10	<10
446	<10	<10	<10	<10	<10	<10
457	<10	<10	<10	<10	<10	<10
464	<10	<10	<10	<10	<10	<10
465	<10	<10	<10	<10	<10	<10
500	<10	<10	<10	<10	<10	<10
504	<10	<10	<10	<10	10	10
510	<10	<10	<10	<10	<10	<10

	Period		Period		Period	
	3	5	3	5	3	5
603	<10	<10	<10	<10	<10	<10
614	<10	<10	<10	<10	<10	<10
615	<10	<10	<10	<10	<10	<10
616	<10	<10	<10	<10	<10	<10
617	<10	<10	<10	<10	<10	<10
619	<10	<10	<10	<10	<10	<10
621	<10	<10	<10	<10	<10	<10
628	<10	<10	<10	<10	<10	<10
630	<10	<10	<10	<10	<10	<10
631	<10	<10	<10	<10	<10	<10
632	<10	<10	<10	<10	<10	<10
633	<10	<10	<10	<10	<10	<10
634	<10	<10	<10	<10	<10	<10
640	<10	<10	<10	<10	<10	<10
641	<10	<10	<10	<10	<10	<10
642	<10	<10	<10	<10	<10	<10
643	<10	<10	<10	<10	<10	<10
644	<10	<10	<10	<10	<10	<10
645	<10	<10	<10	<10	<10	<10
646	<10	<10	<10	<10	<10	<10
647	<10	<10	<10	<10	<10	<10
648	<10	<10	<10	<10	<10	<10
649	<10	<10	<10	<10	<10	<10
650	<10	<10	<10	<10	<10	<10
651	<10	<10	<10	<10	<10	<10
652	<10	<10	<10	<10	<10	<10
653	<10	<10	<10	<10	<10	<10
654	<10	<10	<10	<10	<10	<10

TABLE A-20 TRACE METAL CONCENTRATIONS IN BLOOD SAMPLES FROM INDIVIDUAL PARTICIPANTS (μg/100 ml)

Participant I.D.	Cadmium		Copper	Lead			Mercury		Zinc
	Period 1	Period 5	Period 1	Period 1	Period 2	Period 5	Period 1	Period 5	Period 1
1	0.093	0.105	110.8	8.1	10.8	12.0	0.23	0.30	496
2	0.092	0.149	70.1	5.4	NSC	9.7	0.09	0.18	407
3	0.060	0.049	81.8	12.1	NSC	9.7	0.20	0.28	701
4	0.077	0.124	106.1	9.5	9.9	7.9	0.86	0.16	654
5	0.081	0.042	80.9	8.9	11.5	7.9	0.07	0.17	509
6	0.051	0.107	119.7	16.1	11.8	10.8	0.57	0.20	393
9	0.060	NSC	81.8	6.7	10.3	NSC	0.16	NSC	423
10	0.040	0.064	113.2	9.2	8.9	7.6	0.82	0.12	675
11	0.051	0.080	94.9	13.8	13.9	8.4	0.47	1.70	489
12	0.164	0.061	71.2	12.0	13.0	9.5	0.65	0.31	421
13	0.075	0.089	92.3	19.7	21.6	20.4	0.20	0.38	736
14	0.058	0.180	76.5	12.7	15.1	17.9	0.45	0.31	612
15	0.324	0.089	82.4	8.0	10.2	18.8	0.34	0.28	649
16	0.100	0.094	72.6	9.0	10.2	14.3	0.57	0.60	503
18	0.049	NSC	89.6	12.0	12.6	NSC	0.16	NSC	476
19	0.090	0.063	106.0	6.4	8.9	9.4	0.33	0.24	538
21	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
29	0.048	NSC	111.2	8.5	7.3	NSC	0.34	NSC	579
30	0.094	0.077	115.3	10.2	9.7	10.5	0.24	0.13	435
31	0.305	0.054	119.7	8.8	7.0	8.0	0.37	0.26	482
32	0.065	NSC	121.7	13.2	9.8	NSC	0.26	NSC	675
33	0.094	NSC	114.4	12.5	17.3	NSC	0.57	NSC	728
49	0.063	0.097	129.3	6.1	7.5	8.6	0.69	0.48	530
50	0.051	0.180	88.4	10.1	11.6	11.4	0.33	0.05	556
74	0.075	0.087	103.6	18.6	14.6	13.2	0.16	0.24	526
75	0.048	0.106	98.1	NSC	9.7	8.6	0.16	0.30	649
76	IS	0.132	100.3	16.8	NSC	13.5	0.40	0.16	503
77	IS	NSC	116.7	11.0	NSC	NSC	0.20	NSC	632
78	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
83	0.096	0.101	129.3	11.0	11.0	14.0	0.45	0.19	566
84	0.155	0.166	116.4	10.4	13.2	10.5	0.44	0.01	619
97	0.068	0.123	112.9	21.2	15.2	13.8	0.26	0.28	660
98	IS	0.057	105.1	NSC	6.3	5.5	0.27	0.31	455
99	NSC	NSC	105.5	NSC	NSC	NSC	NSC	NSC	NSC
100	0.182	0.082	NSC	7.3	8.9	11.8	1.07	0.40	544
101	0.040	0.101	108.6	22.0	20.9	19.1	0.36	0.42	719
102	0.146	0.092	99.9	8.0	6.8	4.6	0.74	0.39	877
103	IS	0.152	121.7	7.6	6.9	6.8	0.58	0.38	737
113	0.033	NSC	76.6	9.1	11.3	NSC	0.37	NSC	596
114	0.040	NSC	99.9	16.5	11.2	NSC	0.33	NSC	632
115	IS	NSC	102.6	8.6	7.2	NSC	1.13	NSC	570
116	0.037	NSC	111.9	14.4	13.2	NSC	<0.01	NSC	455
117	0.086	NSC	102.1	12.6	13.4	NSC	0.22	NSC	649
131	0.033	NSC	96.7	7.5	5.9	NSC	0.07	NSC	658
141	0.101	0.105	122.5	13.4	9.5	11.1	0.77	0.35	737
142	0.051	0.149	119.1	10.6	7.9	8.1	0.19	0.44	579

(continued)

TABLE A-20 (continued)

Participant I.D.	Cadmium		Copper	Lead			Mercury		Zinc
	Period 1	Period 5	Period 1	Period 1	Period 2	Period 5	Period 1	Period 5	Period 1
143	IS	0.044	103.9	11.6	5.6	8.7	1.41	0.30	711
144	0.068	0.045	129.5	7.6	7.2	5.0	0.57	0.39	833
145	0.103	0.105	105.8	18.8	15.5	12.9	1.43	0.73	591
146	0.044	0.068	93.3	5.6	5.7	6.7	0.71	0.37	641
157	0.137	0.277	88.6	17.4	16.3	16.6	0.28	0.32	566
158	0.015	0.085	122.8	7.2	6.8	6.8	0.18	0.36	509
159	NSC	0.124	NSC	NSC	NSC	6.8	NSC	0.25	NSC
160	NSC	0.130	NSC	NSC	NSC	7.5	NSC	0.22	NSC
162	0.296	0.094	170.4	5.2	8.0	9.2	0.69	0.18	939
165	0.036	0.042	94.2	9.0	11.3	8.1	0.86	0.38	798
166	0.191	0.135	99.5	5.2	5.4	9.9	0.22	0.18	448
167	NSC	NSC	80.5	5.6	NSC	NSC	0.71	NSC	660
171	NSC	0.073	NSC	NSC	10.7	8.0	NSC	<0.01	NSC
172	NSC	0.111	NSC	NSC	10.7	7.7	NSC	0.11	NSC
177	0.129	0.188	114.9	10.1	13.8	13.0	0.22	0.12	490
178	0.215	0.154	93.3	9.9	9.4	10.6	0.30	0.05	522
179	0.152	0.178	95.5	6.3	7.0	8.6	0.11	0.56	614
180	0.122	0.092	120.3	9.5	10.4	11.4	0.35	0.14	523
181	IS	0.070	77.8	30.6	17.2	14.8	0.61	0.45	614
182	0.075	0.102	95.2	14.7	7.2	8.6	0.13	0.26	702
183	NSC	0.070	NSC	NSC	11.7	9.7	NSC	0.06	NSC
189	0.051	NSC	88.3	13.9	11.1	NSC	0.27	NSC	606
190	0.077	NSC	93.6	4.1	5.3	NSC	0.30	NSC	484
191	0.061	NSC	91.5	5.8	5.5	NSC	0.22	NSC	503
192	0.063	NSC	92.3	7.9	8.3	NSC	0.09	NSC	553
193	NSC	NSC	NSC	NSC	13.2	NSC	NSC	NSC	NSC
194	0.067	NSC	98.6	7.3	6.8	NSC	0.65	NSC	373
195	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
196	0.113	0.089	65.1	16.7	11.3	9.2	1.48	0.50	746
198	0.030	NSC	81.0	10.5	13.5	NSC	0.04	NSC	667
199	0.037	0.092	139.4	21.4	13.2	15.8	0.51	0.37	489
201	0.129	NSC	66.2	7.7	12.2	NSC	0.05	NSC	537
202	NSC	NSC	NSC	NSC	11.1	NSC	NSC	NSC	NSC
206	0.109	0.220	80.2	13.9	9.5	11.1	0.65	0.49	579
207	0.103	0.136	116.8	8.5	8.0	8.6	0.84	0.23	711
208	IS	0.223	91.2	16.3	9.8	9.2	0.34	0.25	728
209	0.114	0.125	109.0	10.1	7.0	9.8	0.21	0.23	592
213	0.069	0.094	108.6	11.4	10.8	9.2	0.37	<0.01	723
214	0.081	0.099	93.3	8.0	10.4	8.7	0.24	0.10	540
226	IS	0.106	80.2	6.4	5.7	6.4	0.22	0.32	649
227	0.137	0.151	96.2	16.9	12.9	12.0	0.22	0.07	482
228	0.133	0.151	50.6	7.8	8.5	7.4	0.65	0.36	428
229	0.054	0.035	108.4	13.2	22.8	15.8	0.49	0.30	708
230	IS	NSC	127.0	14.7	NSC	NSC	8.11	NSC	503
231	0.111	0.068	140.4	8.6	7.5	10.0	1.02	0.82	606
232	NSC	0.105	NSC	NSC	NSC	9.9	NSC	0.03	NSC
233	0.071	0.073	125.3	5.0	9.0	8.5	0.04	0.30	537

(continued)

TABLE A-20 (continued)

Participant I. D.	Cadmium		Copper	Lead			Mercury		Zinc
	Period 1	Period 5	Period 1	Period 1	Period 2	Period 5	Period 1	Period 5	Period 1
235	NSC	0.072	NSC	NSC	NSC	9.0	NSC	0.09	NSC
241	0.111	0.059	93.3	4.8	5.9	8.4	0.16	0.18	684
242	0.026	0.051	98.6	13.7	14.7	16.0	0.68	0.27	540
243	0.034	0.086	104.6	4.8	6.8	6.5	0.61	0.11	428
244	0.058	0.080	105.1	6.3	8.0	8.6	0.68	0.13	441
254	0.090	NSC	125.6	15.3	NSC	NSC	0.66	NSC	641
255	NSC	NSC	NSC	NSC	10.2	NSC	NSC	NSC	NSC
256	0.101	NSC	96.4	7.8	7.0	NSC	0.43	NSC	523
257	0.076	NSC	83.1	13.4	14.8	NSC	0.19	NSC	570
258	0.129	NSC	84.4	12.1	11.0	NSC	0.33	NSC	647
260	0.103	0.057	114.9	13.8	11.2	9.0	0.61	0.16	714
262	0.055	0.128	124.0	15.2	13.4	14.9	0.95	0.37	614
263	0.071	0.136	123.8	13.0	13.6	12.6	0.64	0.24	570
266	0.092	0.044	97.4	11.2	9.8	11.8	2.40	0.44	572
267	IS	0.111	86.1	8.9	6.9	11.2	1.71	0.78	798
268	0.122	0.080	50.6	7.5	9.0	11.6	0.12	0.09	708
273	0.210	0.191	103.9	11.5	12.1	12.5	0.68	0.27	693
275	0.054	0.042	93.6	8.5	5.5	6.5	0.20	0.08	517
276	0.091	0.330	96.2	6.1	5.5	8.0	0.31	0.04	469
278	0.072	0.089	109.7	10.1	13.3	9.5	0.12	0.21	414
284	0.079	NSC	101.1	15.6	16.7	NSC	0.06	NSC	628
290	0.081	0.089	173.8	10.9	6.3	6.2	1.28	0.39	675
293	0.323	NSC	102.6	19.9	15.2	NSC	0.09	NSC	452
294	IS	NSC	100.4	25.1	17.2	NSC	0.28	NSC	519
295	0.094	NSC	72.9	10.3	NSC	NSC	0.18	NSC	667
302	0.116	0.066	86.4	11.0	10.2	9.9	0.15	0.50	670
303	0.148	0.232	82.8	6.7	8.1	11.8	0.07	0.59	740
312	0.050	0.073	90.4	21.8	27.2	14.4	0.80	0.10	638
313	0.068	0.101	110.8	20.9	13.9	17.4	0.44	0.14	579
314	0.150	0.054	63.9	7.8	7.7	NSC	0.50	NSC	386
315	NSC	NSC	NSC	NSC	10.4	9.2	NSC	<0.01	NSC
316	0.123	0.105	62.1	10.7	7.5	6.2	0.82	0.38	638
324	IS	0.123	108.2	7.8	7.8	6.2	0.39	0.17	698
325	0.295	0.146	105.8	7.2	8.3	6.8	0.45	0.27	554
330	0.046	0.135	97.0	11.2	13.5	11.2	1.07	0.39	584
334	0.155	0.249	123.4	17.8	25.8	14.2	0.47	0.09	647
335	0.087	0.049	80.6	11.3	13.2	12.3	0.54	0.19	439
336	0.040	0.072	115.7	15.7	13.3	9.1	0.69	0.08	605
337	0.054	0.064	90.7	17.4	13.0	10.7	0.74	0.26	612
338	IS	0.064	153.3	10.	NSC	11.1	1.19	0.10	451
339	0.142	0.095	95.7	11.8	18.0	16.0	1.15	0.46	541
340	NSC	0.086	NSC	NSC	NSC	9.5	NSC	0.08	NSC
341	NSC	0.180	NSC	NSC	12.0	7.4	NSC	0.05	NSC
342	NSC	NSC	NSC	NSC	7.5	NSC	NSC	NSC	NSC
343	0.131	0.123	96.4	12.6	10.4	8.9	0.54	0.37	562
348	0.103	0.059	99.2	6.9	NSC	5.6	0.46	0.15	564

(continued)

TABLE A-20 (continued)

Participant I. D.	Cadmium		Copper	Lead			Mercury		Zinc
	Period 1	Period 5	Period 1	Period 1	Period 2	Period 5	Period 1	Period 5	Period 1
349	0.091	NSC	55.6	7.4	7.0	NSC	0.35	NSC	565
350	0.124	NSC	98.6	9.8	5.1	NSC	0.11	NSC	544
353	0.087	0.185	95.4	13.9	9.0	8.6	0.24	0.16	693
354	0.118	0.127	99.2	17.1	9.1	11.1	0.24	0.34	572
355	0.092	0.035	120.0	11.9	19.7	14.9	0.38	0.32	474
356	IS	0.078	110.0	13.0	12.0	12.7	0.36	0.22	494
359	0.053	0.138	130.1	13.7	7.4	9.4	0.06	0.21	604
361	IS	0.030	116.4	1.9	7.6	3.8	1.25	0.74	456
362	IS	0.197	94.8	7.1	9.1	6.8	0.38	0.06	425
363	NSC	0.044	NSC	NSC	NSC	12.0	NSC	0.24	NSC
364	0.099	0.106	95.7	17.5	11.0	11.1	0.05	0.08	638
365	0.099	0.042	125.6	8.9	8.2	10.3	0.22	0.17	613
366	IS	0.130	98.6	9.9	8.0	10.4	0.52	0.22	612
367	IS	0.211	81.4	5.6	5.3	6.3	1.20	0.32	813
368	0.098	0.086	111.4	6.0	8.5	9.5	0.92	0.03	548
370	0.040	0.054	125.1	7.7	6.8	10.3	0.07	0.18	477
372	IS	IS	125.6	9.7	9.7	9.9	0.31	IS	605
373	NSC	0.074	NSC	NSC	NSC	5.5	NSC	0.17	NSC
374	0.159	0.125	97.0	16.8	18 9	18.8	0.38	0.42	658
375	NSC	0.204	NSC	NSC	NSC	10.5	NSC	0.05	NSC
378	0.092	0.205	64.2	22.4	NSC	18.0	0.70	0.15	598
383	0.078	NSC	119.9	14.1	NSC	NSC	0.28	NSC	689
384	0.031	NSC	51.6	21.5	NSC	NSC	0.28	NSC	526
385	0.129	0.044	73.3	11.8	12.8	10.2	0.22	0.20	746
386	0.044	0.042	94.8	8.6	4.1	9.6	0.42	0.43	632
387	0.047	0.121	138.6	8.3	9.7	9.9	0.31	0.28	466
388	0.044	0.184	117.2	12.7	13.1	12.9	0.76	0.21	585
390	0.030	0.088	94.0	13.8	10.2	9.9	0.74	0.36	559
391	IS	0.087	110.0	18.1	NSC	14.1	2.17	0.03	783
392	0.060	0.133	97.0	9.8	8.6	12.3	0.19	0.09	612
393	0.044	NSC	109.7	8.3	9.4	NSC	0.49	NSC	536
394	IS	NSC	85.7	13.4	7.4	NSC	0.20	NSC	736
395	0.073	NSC	118.7	13.0	9.7	NSC	1.51	NSC	404
396	IS	NSC	121.9	12.1	NSC	NSC	0.35	NSC	456
397	0.041	NSC	155.0	10.6	5.4	NSC	0.80	NSC	725
398	0.048	0.078	104.6	10.1	7.8	5.8	0.44	0.38	638
399	0.143	0.118	124.1	9.4	7.2	8.0	0.77	0.48	740
400	0.066	0.231	85.7	15.3	10.0	12.3	1.04	0.82	695
402	0.062	NSC	96.4	15.9	12.6	NSC	0.01	NSC	623
403	0.108	0.082	128.2	13.5	16.3	8.0	0.60	0.55	690
405	0.020	0.094	92.3	14.4	7.6	9.2	0.58	0.27	571
406	0.052	0.101	88.2	11.4	8.2	5.6	0.21	0.23	596
407	0.058	0.089	128.0	7.6	6.1	5.1	0.24	0.15	553
408	0.070	0.068	100.5	11.8	12.0	12.5	0.24	0.20	638
412	0.102	NSC	101.7	15.2	12.2	NSC	1.18	NSC	690

(continued)

TABLE A-20 (continued)

Participant I. D.	Cadmium		Copper	Lead			Mercury		Zinc
	Period 1	Period 5	Period 1	Period 1	Period 2	Period 5	Period 1	Period 5	Period 1
413	0.101	NSC	123.8	9.2	7.3	NSC	0.24	NSC	632
414	NSC	0.066	NSC	NSC	NSC	9.9	NSC	0.23	NSC
415	0.174	0.155	90.8	17.5	14.5	10.3	0.01	0.18	391
416	IS	0.063	96.4	13.5	15.0	13.3	0.16	0.15	323
417	120	0.197	98.5	26.1	29.0	18.4	0.44	0.13	622
418	.076	0.040	86.1	20.2	25.8	19.3	0.20	0.25	664
419	0.125	0.125	92.9	18.9	16.5	13.5	0.06	0.28	585
421	0.044	NSC	96.4	15.9	11.1	NSC	0.62	NSC	502
422	0.032	0.040	110.5	10.3	7.2	7.6	0.36	0.53	630
423	0.094	0.048	88.2	10.3	11.0	10.9	0.64	0.45	638
424	0.208	0.048	96.4	7.8	6.6	7.6	0.43	0.09	439
426	0.068	0.067	83.2	8.9	8.5	8.0	0.61	0.10	537
428	0.111	0.062	115.9	11.6	12.5	8.0	0.28	0.16	687
429	0.312	0.330	108.7	11.9	8.9	8.6	0.36	0.16	681
430	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
438	IS	NSC	146.7	8.8	13.5	NSC	0.88	NSC	658
441	IS	0.080	126.2	6.0	5.9	11.1	0.51	0.41	711
442	0.040	0.095	127.7	12.5	8.2	7.4	0.29	0.09	488
443	IS	0.133	130.8	9.9	8.5	9.9	0.16	0.43	693
445	0.059	0.143	81.6	6.7	9.2	9.0	0.28	0.10	638
446	IS	IS	124.2	12.0	11.9	9.9	0.21	IS	491
449	IS	0.230	79.7	25.4	23.5	21.4	0.17	0.34	640
450	IS	0.063	97.6	9.5	NSC	8.3	8.14	0.09	373
451	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
452	IS	NSC	98.0	11.8	10.5	NSC	0.51	NSC	529
453	0.051	NSC	101.0	13.4	11.9	NSC	0.65	NSC	478
454	0.090	NSC	172.2	12.6	11.5	NSC	0.71	NSC	612
455	0.078	0.054	129.2	20.4	18.1	14.0	0.27	0.39	784
457	0.047	0.057	139.8	9.3	9.0	8.0	0.51	0.16	701
458	0.040	0.154	115.7	9.9	10.1	7.9	0.48	0.08	351
459	0.029	0.072	104.6	7.6	9.9	7.2	0.15	0.19	460
460	0.060	0.101	79.2	7.5	5.7	4.8	0.15	0.23	723
461	IS	0.087	105.5	6.4	7.8	3.7	0.67	0.37	647
464	IS	0.171	89.7	10.1	18.9	12.2	0.19	0.28	640
465	0.121	0.061	37.5	10.	14.5	11.0	0.11	0.17	526
466	0.030	NSC	77.2	12.5	6.5	NSC	0.18	NSC	613
467	0.049	NSC	95.0	13.6	12.7	NSC	0.16	NSC	587
500	IS	0.216	147.8	17.2	NSC	11.4	0.48	0.12	719
501	0.045	NSC	98.9	14.1	NSC	NSC	0.30	NSC	664
502	0.099	NSC	63.9	8.6	10.1	NSC	0.99	NSC	720
503	0.090	NSC	107.3	12.0	11.7	NSC	0.07	NSC	562
504	0.070	0.086	89.7	8.7	9.1	8.2	0.29	0.12	417
505	NSC	0.021	NSC	NSC	NSC	12.3	NSC	0.12	NSC
506	IS	0.072	141.4	13.9	14.3	7.6	0.33	0.12	597
507	IS	0.062	100.3	12.6	7.7	9.5	0.61	0.13	675

(continued)

TABLE A-20 (continued)

Participant I. D.	Cadmium		Copper	Lead			Mercury		Zinc
	Period 1	Period 5	Period 1	Period 1	Period 2	Period 5	Period 1	Period 5	Period 1
508	0.169	0.251	119.4	12.9	14.5	12.1	0.51	0.27	605
509	0.057	0.064	149.2	10.1	10.2	10.5	0.80	1.06	748
510	0.050	0.078	101.0	14.1	15.5	18.0	0.56	0.28	660
511	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
512	NSC	0.091	NSC	NSC	15.3	10.5	NSC	0.09	NSC

TABLE A-21 TRACE METAL CONCENTRATIONS IN FECES SAMPLES FROM INDIVIDUAL PARTICIPANTS (μg/g)

Participant I.D.	Cadmium Period 1	Cadmium Period 5	Copper Period 1	Lead Period 1	Lead Period 5	Mercury Period 1	Mercury Period 5	Zinc Period 1
1	0.138	0.180	11.3*	0.94*	0.32	0.17	0.04	104*
2	0.082	0.155	11.9	1.75*	0.56	0.10	0.13	162*
3	0.134	0.086	17.1	1.04	0.77	0.05	0.16	78
4	0.119	0.069	5.7	0.93	0.15	0.04	<0.04	56
5	0.154	0.208	14.2*	1.15*	0.66	0.06*	0.07	78*
6	0.123	0.235	5.2	1.09	0.51	<0.04	<0.04	55
9	0.243	0.148	15.4	0.86	1.20	0.11	0.21	162*
10	IS	0.210	16.0	0.83	0.45	0.19	0.11	99
11	0.112	0.114	12.1	1.09	1.10	0.12	0.16	141
12	0.122	0.155	12.5	0.88	0.38	0.26	0.31	91
13	0.307	0.030	18.9*	3.69*	0.69	0.64	0.29	122*
14	0.061	0.061	16.1	0.63	0.35	0.41	0.18	111
15	0.125	NSC	7.2	0.20	NSC	0.22	NSC	65
16	0.184	0.193	9.8	0.43	0.33	0.20*	0.27	58
18	0.163	0.511	6.0	0.48	0.73	0.[illegible]3*	0.23	35
19	0.265	0.127	17.6	2.04	1.49	0.27	0.09	171
21	0.155	NSC	18.6	0.90	NSC	0.04	NSC	117
29	0.295	0.210	31.1*	2.38*	1.53	0.16	0.58	182*
30	0.355	0.098	18.3	2.07	0.98	<0.04	0.04	126
31	0.121	0.136	25.3	1.70	0.61	0.14	0.41	155
32	0.131	0.029	27.3*	2.08*	1.29	<0.04	IS	144*
33	0.130	0.144	7.0	1.11*	0.72	<0.04	<0.04	86
49	NSC	0.083	NSC	NSC	0.68	NSC	0.14	NSC
50	0.086	0.121	12.9*	0.58*	0.38	0.20*	0.05	85*
70	NSC	NSC	NSC	NSC	NSC	<0.04	NSC	NSC
74	0.164	0.054	22.4	2.15	0.24	0.09	0.27	96
75	0.051	0.150	5.3	1.16	0.55	<0.04	0.08	34
76	NSC	0.148	NSC	NSC	1.78	NSC	0.17	NSC
77	0.207	0.130	14.0	0.75	1.24	<0.04	0.04	63
78	IS	0.200	32.7	1.14	1.06	0.06*	0.04	99
83	0.090	0.261	10.2	0.53	0.94	<0.04	0.05	65
84	0.161	0.038	13.9	0.82	0.62	<0.04	<0.04	128
97	0.087	0.073	10.6	0.29	0.55	0.14	0.12	22
98	IS	0.318	16.0	0.68	IS	0.09	IS	85
99	0.188	0.157	23.9	0.80	0.56	<0.04	<0.04	89
100	0.148	0.116	24.6	1.27	IS	0.04	IS	125
101	0.223	0.054	27.8	0.89	0.37	<0.04	<0.04	44
102	0.373	0.106	28.8*	0.60*	0.40	0.35	0.68	106*
103	0.172	0.269	28.8*	1.11*	1.16	0.17*	<0.04	154*
113	0.331	NSC	15.7	1.46	NSC	<0.04*	NSC	123
114	0.210	NSC	14.7	2.18	NSC	0.14	NSC	67
115	0.040	NSC	17.7	1.10	NSC	<0.04	NSC	168
116	0.240	NSC	18.3	2.49	NSC	0.18	NSC	104
117	0.154	NSC	22.2	1.56	NSC	<0.04	NSC	72*
131	0.097	0.146	13.0	0.85	0.53	0.13	0.08	106
141	0.180	0.340	13.2	1.29	IS	<0.04	<0.04	89

(continued)

TABLE A-21 (continued)

Participant I.D.	Cadmium		Copper	Lead		Mercury		Zinc
	Period 1	Period 5	Period 1	Period 1	Period 5	Period 1	Period 5	Period 1
142	0.246	0.023	14.2*	1.22*	1.25	0.53	0.16	62*
143	0.161	0.029	9.6*	0.46*	IS	0.05*	IS	49*
144	0.184	NSC	15.5	1.16	NSC	0.20	NSC	55
145	0.161	0.079	21.3	1.93*	0.31	0.30	0.04	117
146	0.214	0.140	21.3	1.12	0.70	0.15	0.06	97
157	0.201	0.070	11.8	0.38	0.79	0.13	0.17	130
158	0.055	<0.014	16.1	0.62	3.72	0.29	0.07	83
159	0.135	0.072	6.5	0.19	1.46	0.05	0.04	61
160	IS	0.086	5.3	0.49	1.99	0.51	<0.04	1298*
162	0.176	0.042	10.9	0.34	0.21	0.31	0.07	96
165	0.666	0.038	26.9	1.27	0.49	0.63	0.61	183
166	0.180	0.193	18.2	0.80	0.46	0.08	<0.04	104
167	0.258	NSC	33.5	0.85	NSC	0.88	NSC	88
171	0.173	0.488	17.2	1.02	0.73	0.22	<0.04	36
172	IS	0.034	11.2	0.29	0.50	1.57*	0.08	53
177	0.074	0.057	7.5*	0.33	0.47	0.09	<0.04	54
178	0.030	0.114	27.0	0.76	0.61	<0.04	0.06	130
179	0.087	<0.014	23.0	1.18	0.98	<0.04	0.09	125
180	0.142	0.024	26.0	2.85	0.59	0.19	0.22	126
181	0.105	0.075	11.7	0.17	0.24	<0.04	<0.04	126
182	0.213	0.127	17.5*	0.38*	0.53	0.17*	0.21	120*
183	0.318	0.150	8.2	0.70	1.10	<0.04	<0.04	91
189	0.299	NSC	21.3*	1.54*	NSC	0.07*	NSC	186*
190	0.131	NSC	14.2*	0.54*	NSC	0.11*	NSC	60*
191	0.172	NSC	18.2	0.87	NSC	0.18	NSC	130*
192	IS	NSC	11.9	0.46	NSC	0.07	NSC	51
193	0.276	NSC	16.8	1.36	NSC	<0.04	NSC	129
194	0.298	NSC	14.1	0.66	NSC	0.11	NSC	121
195	0.192	NSC	22.6*	1.67*	NSC	<0.04	NSC	147*
196	IS	<0.014	14.8	1.40	0.31	0.19	0.09	85
198	0.358	0.091	14.5	1.04	0.93	<0.04	<0.04	128
199	0.080	0.035	19.1	2.39	0.48	0.19	0.05	145
201	0.085	NSC	20.4	0.82	NSC	0.13	NSC	73
202	0.127	NSC	23.4	1.34	NSC	<0.04	NSC	149
206	0.184	0.098	32.5	<2.05*	0.24	0.12*	0.27	188*
207	0.266	0.065	26.0	2.55	0.43	0.29	0.05	124
208	0.204	0.053	13.1	2.68	0.32	0.06	<0.04	68
209	0.237	0.188	21.5*	3.12*	0.38	0.40	<0.04	171*
213	0.079	0.121	19.6	0.12	0.41	<0.04	<0.04	73
214	0.064	0.173	24.3	0.93*	0.35	<0.04	<0.04	98
226	0.067	0.106	23.2	1.21	0.81	0.26	0.42	104
227	0.169	0.099	15.3	1.06	0.13	0.17	0.22	153
228	0.112	0.106	14.4	0.28	0.18	0.49	0.36	96
229	0.205	0.442	26.5	1.98*	0.79	0.12*	0.12	175*
230	NSC	0.288	NSC	NSC	11.3	NSC	<0.04	NSC
231	0.103	0.094	26.9	0.39	0.47	0.12	0.15	138

(continued)

TABLE A-21 (continued)

Participant I.D.	Cadmium		Copper	Lead		Mercury		Zinc
	Period 1	Period 5	Period 1	Period 1	Period 5	Period 1	Period 5	Period 1
232	0.057	0.196	27.2	1.14	1.28	<0.04	<0.04	74
233	0.052	0.254	24.0	2.39	0.61	0.25	0.16	138
235	0.135	0.149	12.8*	2.85*	0.63	<0.04	<0.04	89*
239	0.147	NSC	27.1	0.62	NSC	0.07	NSC	95
241	0.086	0.115	12.3	0.60	0.67	0.09	0.12	83
242	0.151	0.051	17.4	1.81	0.61	0.06	0.09	74
243	0.112	NSC	14.2	0.48	NSC	0.06	NSC	111*
244	0.169	0.113	22.4*	1.26*	0.75	0.26*	0.10	73*
254	0.134	NSC	12.2	0.60	NSC	0.05	NSC	82
255	0.301	NSC	20.3*	11.98*	NSC	0.07	NSC	74*
256	0.106	NSC	22.7	3.32*	NSC	0.13*	NSC	92*
257	0.141	NSC	NSC	NSC	NSC	NSC	NSC	NSC
258	0.049	NSC	18.2	2.76	NSC	0.09	NSC	79
260	0.086	0.244	19.3	0.40	0.18	<0.04	<0.04	70
262	0.039	0.034	4.4*	1.65*	0.52	0.16*	<0.04	71*
263	0.326	0.058	13.6	2.36	0.91	<0.04	<0.04	151
266	0.163	0.078	10.7	0.62	0.56	<0.04	<0.04	58
267	0.115	0.090	13.2	1.37*	0.85	0.38	0.13	179*
268	0.168	0.060	19.9	0.90	1.06	<0.04	<1.14	49
273	0.112	0.059	6.0	0.25	0.45	<0.04	IS	65
275	0.170	0.237	17.5	0.54	0.51	<0.04	<0.04	96
276	0.062	0.178	15.2	0.98	0.93	0.06	<0.04	110
278	NSC	0.051	NSC	NSC	0.18	NSC	<0.04	NSC
284	0.085	0.014	12.0	0.51	0.84	0.10	0.05	69
290	0.114	0.035	9.6	2.01	0.59	0.39	0.31	103
293	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
294	NSC	0.125	NSC	NSC	0.75	NSC	0.08	NSC
295	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
302	0.048	0.098	17.4	0.79	1.02	<0.04	0.09	110
303	IS	0.057	17.0	0.37	1.51	NSC	0.11	82
312	0.131	0.052	8.8	1.06	0.72	<0.04	0.05	74
313	0.143	0.267	4.7	0.28	0.48	<0.04	0.09	50
314	0.385	NSC	13.3	0.60	NSC	<0.04	NSC	85
315	0.139	0.253	9.7	1.99	0.91	<0.04	<0.04	75
316	0.085	0.204	10.0	1.19	0.59	<0.04*	<0.08	97
324	0.106	0.101	8.1	0.56	1.14	<0.04	0.08	48
325	0.114	0.049	13.3	1.13	0.45	3.51*	0.23	66
330	0.233	0.093	10.1	0.69	1.57	0.06	0.05	38
334	0.118	IS	8.7	0.59	0.73	0.20	IS	99
335	0.141	0.133	16.7	0.70	0.15	0.05	<0.04	82
336	0.140	0.026	15.9	1.01	0.27	<0.04	0.04	62
337	0.176	0.026	10.7	0.88	0.56	0.05	<0.04	74
338	0.160	0.069	17.7*	1.01*	0.41	<0.04*	<0.04	69*
339	NSC	0.261	NSC	NSC	0.61	NSC	0.31	NSC
340	0.172	0.036	14.7	2.06	1.09	0.18	<0.04	59
341	NSC	0.016	NSC	NSC	0.73	NSC	0.04	NSC
342	0.056	0.045	15.2	0.42	0.59	<0.04	0.07	106

(continued)

TABLE A-21 (continued)

Participant I.D.	Cadmium		Copper	Lead		Mercury		Zinc
	Period 1	Period 5	Period 1	Period 1	Period 5	Period 1	Period 5	Period 1
343	0.110	0.098	8.4	0.63	< 0.10	0.07	0.05	102
348	0.118	NSC	10.2	0.43	NSC	< 0.04	NSC	73
349	0.063	0.030	26.9	0.57	IS	0.13	IS	95
350	0.130	0.109	12.3*	0.51*	< 0.10	0.06*	< 0.04	86*
353	0.176	NSC	11.4	0.67	NSC	0.24	NSC	72
354	0.106	0.226	17.3	1.18	0.56	0.49	0.06	93
355	0.094	0.217	11.3*	0.88	0.15	0.08	0.04	52*
356	0.258	0.306	9.3*	2.43*	0.67	< 0.04	0.28	44*
359	0.150	0.026	29.4*	0.52*	0.73	0.22	0.35	114*
361	IS	< 0.014	26.0	0.60	0.48	0.17	0.21	79
362	0.062	NSC	14.6*	0.88*	NSC	< 0.04*	NSC	64
363	0.147	NSC	19.3	0.91	NSC	< 0.04*	NSC	88
364	0.202	0.283	7.3	0.46	0.85	< 0.04	< 0.04	110
365	0.331	0.117	18.5	1.03	2.48	0.05	< 0.04	119
366	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
367	0.144	0.113	18.8	0.74	0.85	0.26	0.11	96
368	IS	0.131	18.1	0.66	0.95	1.04*	0.05	130
370	NSC	0.230	NSC	NSC	1.88	NSC	0.70	NSC
372	0.137	0.102	12.9	1.32	0.30	< 0.04	< 0.04	107
373	NSC	0.119	NSC	NSC	0.83	NSC	< 0.04	NSC
374	NSC	0.110	NSC	NSC	0.45	NSC	0.31	NSC
375	0.382	NSC	24.6	2.43	NSC	< 0.04	NSC	156
378	0.076	0.134	21.6	1.10	0.24	< 0.04	< 0.04	70
383	0.090	NSC	16.5	3.06*	NSC	0.13*	NSC	166*
384	0.210	NSC	8.9*	0.55*	NSC	0.05*	NSC	56*
385	NSC	0.109	NSC	NSC	0.43	NSC	0.04	NSC
386	0.058	0.184	5.3	0.27	0.87	0.10	0.10	52
387	0.237	NSC	29.6	1.72*	NSC	0.14*	NSC	167*
388	0.080	0.014	26.1	1.79	0.54	0.48	0.08	149
390	0.260	0.049	32.6*	1.17*	0.35	< 0.04	0.13	85*
391	0.089	0.048	9.7	1.69	1.28	< 0.04	< 0.04	78
392	0.209	0.019	47.3	2.89	0.32	0.16	0.05	187
393	0.052	0.017	32.4	2.20	0.72	< 0.04	< 0.04	195
394	0.190	NSC	9.1	0.39	NSC	0.46	NSC	60
395	0.184	NSC	14.3	1.37	NSC	0.11	NSC	72
396	0.255	NSC	12.4	4.91*	NSC	< 0.04	NSC	67*
397	0.223	NSC	12.5	3.04	NSC	0.31	NSC	100
398	0.060	0.049	26.0	1.27	0.98	0.43	0.37	103
399	0.155	0.165	12.7	0.95	0.35	0.23	0.28	103
400	0.106	0.113	30.8	1.68	0.96	0.62	0.59	181
402	IS	NSC	19.8*	2.19*	NSC	0.13	NSC	205*
403	IS	0.027	27.9	1.56	0.45	NSC	0.19	289*
405	0.187	0.174	14.0	1.54	0.17	0.21	< 0.04	106
406	0.191	0.254	21.6	1.53	0.35	0.13	0.17	69
407	0.048	0.065	18.8	0.82	0.24	0.07	0.15	96
408	NSC	0.219	NSC	NSC	0.19	NSC	0.14	NSC

(continued)

TABLE A-21 (continued)

Participant I.D.	Cadmium		Copper	Lead		Mercury		Zinc
	Period 1	Period 5	Period 1	Period 1	Period 5	Period 1	Period 5	Period 1
412	0.272	NSC	15.0*	0.82*	NSC	0.07*	NSC	126*
413	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
414	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
415	0.195	NSC	12.8*	3.06*	NSC	< 0.04	NSC	196*
416	0.087	0.200	14.6	1.94	0.29	< 0.04	< 0.04	142
417	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
418	0.089	0.133	30.0	2.19	0.54	0.20	0.08	151
419	0.155	0.057	8.7	0.90	0.38	0.10	< 0.04	89
421	IS	< 0.014	8.2	0.82	0.61	10.39*	0.31	80
422	0.226	0.126	12.9	0.87	0.64	0.15	0.10	81
423	0.036	0.102	15.4	1.56	1.84	< 0.04	< 0.04	96
424	0.217	0.243	10.1	0.48	0.29	0.14	0.12	108
426	0.090	0.067	3.7	0.33	1.28	0.09	< 0.04	70
428	0.070	0.155	2.8	1.04	1.63	0.06	0.07	59
429	0.109	0.126	11.7	0.86	0.16	0.16	0.12	81
430	0.089	0.059	10.8	1.22	0.45	< 0.04	< 0.04	63
438	0.114	NSC	9.7	0.61	NSC	0.15	NSC	153
441	0.094	0.068	17.1	0.92	2.24	0.13	0.36	151
442	0.097	0.174	9.7	0.81	IS	< 0.04	IS	61
443	0.255	0.166	14.2	1.14	0.84	0.08	0.31	96
445	0.144	0.184	12.2	0.71	0.46	0.18	< 0.04	113
446	0.281	NSC	10.6	2.19	NSC	< 0.04	NSC	97
449	0.211	0.127	9.1	1.37	0.89	0.43	0.10	102
450	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
451	0.075	NSC	7.7	0.69	NSC	< 0.04	NSC	46
452	0.239	NSC	11.2	0.70	NSC	0.33	NSC	77
453	0.052	NSC	17.2	1.39	NSC	0.13	NSC	124
454	0.181	NSC	13.8	2.41	NSC	0.29	NSC	149
455	0.076	0.033	14.0	0.76	0.62	0.04	< 0.04	113
457	0.164	0.057	11.2	0.55*	1.23	0.15	0.06	144*
458	0.175	< 0.014	10.0	0.97	1.25	0.14	< 0.04	97
459	0.134	0.078	20.8	0.89	0.27	0.04	0.16	96
460	0.149	0.075	25.7	1.12*	0.29	0.18	0.23	97*
461	0.201	NSC	35.8	0.84*	NSC	0.18*	NSC	125*
464	0.119	0.029	13.8	0.83	1.20	0.06	0.08	85
465	IS	0.108	19.1	1.36	1.05	0.06	0.13	120
466	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
467	0.047	NSC	3.1*	0.18*	NSC	0.07*	NSC	39*
500	0.126	NSC	24.6	2.72*	NSC	< 0.04	NSC	66*
501	0.091	NSC	13.0	0.92	NSC	0.13	NSC	68
502	0.170	NSC	13.6	0.71	NSC	0.23	NSC	85
503	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
504	NSC	0.151	NSC	NSC	1.04	NSC	< 0.04	NSC
505	0.240	0.102	20.8	1.97	1.58	0.06	< 0.04	108
506	0.226	0.187	21.7	1.62	0.19	< 0.04	< 0.04	110
507	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
508	NSC	0.370	NSC	NSC	0.53	NSC	0.10	NSC
509	0.099	0.335	22.1	1.54*	0.97	0.52	0.25	174*
510	0.088	0.136	7.2	1.47	0.15	< 0.04	< 0.04	99
512	NSC	0.245	NSC	NSC	0.68	NSC	0.05	NSC

(continued)

TABLE A-21 (continued)

Participant I.D.	Cadmium Period 5
600	0.157
601	0.165
602	0.066
603	0.169
614	0.033
615	0.071
619	0.029
621	0.205
622	0.048
623	0.057
628	0.034
630	0.054
631	0.113
632	0.211
634	0.287
640	0.016
641	0.068
642	0.127
643	0.143
644	0.014
645	0.125
646	0.159
647	0.067
648	0.048
650	0.199
651	0.105
653	0.027
654	0.105

TABLE A-22 TRACE METAL CONCENTRATIONS IN HAIR SAMPLES FROM INDIVIDUAL PARTICIPANTS (μg/g)

Participant I. D.	Cadmium		Copper	Lead		Mercury		Zinc
	Period 1	Period 5	Period 1	Period 1	Period 5	Period 1	Period 5	Period 1
1	0.68	0.91	26.4	12.1	13.2	0.67	0.82	307
2	<0.13	<0.13	12.0	4.6	1.7	0.42	0.27	232
3	0.41	0.31	15.5	12.0	11.4	0.45	IS	155
4	1.48	1.06	18.1	24.4	29.1	0.72	IS	108
5	0.48	0.53	NSC	NSC	17.4	0.67	IS	123
6	0.47	1.43	34.9	5.6	17.6	0.36	0.64	226
9	0.93	0.25	36.7	12.5	6.8	0.62	IS	110
10	0.63	0.52	25.0	12.7	7.4	0.24	IS	162
11	0.43	<0.13	14.2	4.8	9.4	1.34	IS	143
12	0.26	<0.13	12.7	13.6	9.5	0.50	IS	342
13	2.10	0.25	56.8	24.9	48.7	0.19	IS	770
14	0.18	0.43	12.6	7.1	4.8	0.46	IS	221
15	0.27	0.13	12.0	2.9	5.0	0.70	IS	192
16	0.48	1.83	15.5	15.8	75.8	1.37	IS	273
18	0.81	1.03	21.4	24.7	29.1	0.73	0.33	91
19	0.38	0.17	19.2	6.6	6.5	0.54	IS	127
21	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
29	0.58	0.32	67.8	5.9	6.2	0.49	IS	162
30	0.42	0.59	31.6	7.9	<0.9	0.38	0.21	112
31	0.32	0.51	35.0	4.0	4.3	0.48	<0.17	162
32	0.83	0.36	22.9	11.2	7.7	0.50	IS	98
33	0.95	1.03	21.0	14.4	16.1	0.37	0.27	45
49	0.15	NSC	149.3	5.2	NSC	0.65	NSC	223
50	0.68	2.18	56.4	10.1	7.8	0.38	IS	188
70	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
74	1.21	0.33	15.2	11.4	11.3	0.60	IS	116
75	<0.13	<0.13	93.7	2.2	3.4	0.95	0.59	186
76	1.20	0.96	24.3	39.0	19.3	0.84	0.34	189
77	0.55	0.15	22.4	23.8	5.1	0.47	IS	68
78	2.20	3.14	20.6	11.7	26.6	1.79	0.42	102
83	<0.13	0.14	52.7	2.9	1.0	<0.17	<0.17	38
84	<0.13	<0.13	28.1	3.6	4.6	0.19	0.35	169
97	1.41	0.43	51.1	20.6	18.7	0.41	0.31	176
98	1.37	1.71	19.5	16.6	22.0	0.55	IS	85
99	1.39	1.14	60.0	26.2	24.5	1.12	0.47	148
100	1.25	0.20	43.1	8.9	5.2	1.69	IS	150
101	0.60	0.72	27.4	37.8	358.8	0.52	0.58	102
102	0.43	0.15	22.1	4.6	2.8	1.22	0.90	183
103	1.20	0.46	63.4	11.8	5.3	0.35	0.47	128
113	0.55	NSC	52.7	5.4	NSC	0.47	NSC	165
114	0.63	NSC	96.9	9.5	NSC	0.55	NSC	125
115	0.36	NSC	52.4	5.0	NSC	0.22	NSC	126
116	0.83	NSC	71.6	7.7	NSC	0.27	NSC	140
117	3.94	NSC	71.6	4.0	NSC	0.81	NSC	144
131	1.60	0.29	72.0	12.6	3.4	0.64	0.99	150

(continued)

TABLE A-22 (continued)

Participant I.D.	Cadmium		Copper	Lead		Mercury		Zinc
	Period 1	Period 5	Period 1	Period 1	Period 5	Period 1	Period 5	Period 1
141	1.42	0.74	38.4	24.7	12.2	1.40	IS	141
142	1.24	0.53	50.0	31.1	13.5	1.14	0.69	336
143	0.93	0.84	33.2	17.9	8.0	1.19	0.68	141
144	0.64	0.24	48.7	6.6	6.2	1.17	IS	147
145	<0.13	0.59	185.7	9.0	7.5	1.47	IS	365
146	<0.13	0.13	97.7	4.7	1.9	0.72	0.46	126
157	1.14	0.34	50.1	14.5	9.5	0.59	IS	140
158	<0.13	<0.13	28.9	8.0	5.8	0.49	IS	147
159	0.78	0.83	17.3	9.7	20.4	0.47	IS	73
160	1.19	0.41	24.3	18.2	20.9	1.21	IS	71
162	<0.13	0.30	128.2	4.7	3.8	0.37	IS	171
165	0.57	0.24	25.2	11.1	5.9	1.31	0.17	139
166	0.16	0.13	19.2	0.9	3.7	0.69	0.17	172
167	0.18	NSC	32.3	9.9	NSC	0.40	NSC	122
171	1.46	1.31	59.9	29.1	30.0	1.11	IS	79
172	1.41	1.28	32.5	10.5	8.7	0.49	IS	145
177	1.45	0.88	60.6	17.0	18.5	0.51	IS	128
178	1.51	0.20	196.7	6.2	3.0	0.81	0.17	191
179	3.53	2.20	182.2	31.6	10.5	1.31	0.48	163
180	3.29	0.86	74.4	19.2	15.3	0.32	IS	62
181	0.71	0.43	44.0	18.6	11.8	0.35	0.26	139
182	<0.13	<0.13	31.3	<0.9	1.7	0.24	IS	165
183	0.92	0.60	23.7	17.4	13.7	0.32	IS	43
189	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
190	0.14	NSC	113.6	2.0	NSC	0.28	NSC	169
191	0.62	NSC	14.4	14.9	NSC	0.29	NSC	53
192	0.78	NSC	39.1	15.2	NSC	0.28	NSC	57
193	0.41	NSC	15.7	17.6	NSC	0.70	NSC	195
194	4.05	NSC	18.8	10.9	NSC	0.19	NSC	2,132
195	1.91	NSC	20.3	83.2	NSC	0.27	NSC	960
196	1.76	0.59	35.2	18.1	6.0	1.09	0.49	93
198	1.01	0.88	29.5	27.9	12.0	1.13	0.54	166
199	0.37	0.18	57.0	7.7	5.2	1.69	IS	109
201	<0.13	NSC	44.2	1.0	NSC	0.76	NSC	196
202	1.27	NSC	26.6	15.9	NSC	1.52	NSC	481
206	1.08	0.17	119.4	8.9	9.9	0.59	0.32	177
207	0.26	0.29	88.2	4.3	6.4	0.65	0.55	160
208	2.28	0.42	84.7	39.7	11.3	0.35	0.43	125
209	0.88	0.27	55.1	12.0	4.3	0.40	0.21	139
213	<0.13	0.18	66.5	<0.9	3.9	0.71	IS	188
214	0.38	14.39	39.0	9.8	2.3	0.34	0.21	99
226	3.90	<0.13	37.2	4.5	2.1	<0.17	IS	2,006
227	0.26	0.19	49.6	3.9	4.6	0.17	IS	122
228	0.13	0.26	71.5	4.6	5.8	0.24	IS	186
229	0.64	0.23	55.2	31.3	9.3	<0.17	0.33	133
230	0.48	1.10	66.2	11.6	11.3	<0.17	1.10	93

(continued)

TABLE A-22 (continued)

Participant I. D.	Cadmium		Copper	Lead		Mercury		Zinc
	Period 1	Period 5	Period 1	Period 1	Period 5	Period 1	Period 5	Period 1
231	<0.13	0.16	71.2	1.7	1.9	0.27	2.59	189
232	0.66	2.11	17.9	13.0	21.4	0.19	IS	112
233	4.69	<0.13	71.2	3.3	4.1	<0.17	<0.17	2,408
235	2.07	1.39	46.3	22.4	21.3	0.45	IS	135
239	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
241	1.41	<0.13	158.2	8.1	4.3	0.61	0.58	119
242	0.53	0.23	36.6	3.2	6.3	1.04	IS	157
243	0.36	0.21	22.3	8.4	11.3	0.29	IS	123
244	0.65	1.86	28.2	17.8	29.0	0.22	IS	134
254	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
255	1.96	NSC	108.2	31.2	NSC	1.46	NSC	117
256	0.36	NSC	161.1	4.6	NSC	0.21	NSC	272
257	1.24	NSC	52.3	18.0	NSC	1.46	NSC	124
258	<0.13	NSC	94.5	47.0	NSC	0.44	NSC	165
260	1.44	0.68	34.4	26.7	56.6	0.29	0.19	114
262	0.36	0.15	20.4	164.6	68.3	0.56	0.86	163
263	0.70	0.51	16.3	223.3	13.1	0.46	0.21	293
266	1.05	0.51	15.5	4.6	7.0	0.31	IS	163
267	0.23	0.29	33.7	6.6	2.0	0.58	0.84	167
268	0.79	0.20	47.2	6.1	5.1	0.41	0.21	161
273	2.21	0.51	25.6	306.0	3.0	0.45	IS	57
275	1.86	0.69	34.6	9.7	5.7	0.77	0.63	208
276	2.44	0.35	37.9	13.3	3.7	0.56	0.22	225
278	3.49	3.07	39.8	21.9	14.7	0.33	<0.17	159
284	1.45	1.88	20.6	17.1	20.0	0.36	IS	116
290	0.46	0.35	11.9	12.1	11.0	0.72	0.64	137
293	0.16	NSC	71.2	6.3	NSC	0.93	NSC	176
294	0.32	0.35	14.0	9.6	5.8	0.45	IS	2,546
295	0.86	NSC	13.6	8.1	NSC	0.20	NSC	171
302	0.46	0.70	29.3	2.6	18.7	0.21	0.20	151
303	1.77	0.31	13.7	2.2	9.0	<0.17	IS	1,031
312	1.19	5.31	19.0	29.0	91.3	0.90	0.41	165
313	2.94	2.75	37.6	32.4	98.0	0.38	IS	534
314	0.13	0.76	17.1	<0.9	8.1	0.55	0.30	141
315	1.13	0.46	11.6	13.4	6.5	0.55	IS	390
316	<0.13	0.18	11.9	3.7	4.3	0.43	IS	396
324	2.33	<0.13	16.5	2.6	1.8	0.59	IS	109
325	<0.13	0.25	10.1	4.7	5.2	0.55	IS	191
330	1.12	0.55	18.7	5.5	3.9	0.24	IS	151
334	0.82	1.03	41.2	25.4	48.7	0.43	0.22	160
335	0.43	0.15	60.0	11.8	3.5	1.03	0.38	144
336	1.75	0.2	[illegible]5.4	10.0	1.6	36.05	0.26	129
337	0.73	0.44	26.9	6.8	3.9	1.87	IS	142
338	1.43	1.94	22.5	12.7	16.3	2.66	0.80	101
339	0.32	0.27	123.9	13.1	24.2	2.15	0.29	109

(continued)

TABLE A-22 (continued)

Participant I. D.	Cadmium		Copper	Lead		Mercury		Zinc
	Period 1	Period 5	Period 1	Period 1	Period 5	Period 1	Period 5	Period 1
340	0.79	0.41	11.8	16.1	7.4	1.20	0.25	45
341	0.68	0.87	14.6	20.2	9.3	1.12	0.39	42
342	1.41	0.16	28.4	42.2	<0.9	0.28	IS	989
343	1.28	0.89	21.3	71.3	21.4	0.52	0.72	115
348	<0.13	0.62	13.0	6.8	21.5	0.59	0.22	296
349	<0.13	<0.13	10.5	3.1	<0.9	0.25	IS	123
350	NSC	<0.13	NSC	NSC	<0.9	NSC	0.40	NSC
353	1.54	0.17	28.1	3.4	<0.9	0.57	<0.17	651
354	1.63	0.85	17.9	17.7	16.8	0.73	IS	76
355	1.68	0.81	13.9	14.9	12.4	0.59	0.84	96
356	0.94	0.37	14.8	20.8	11.8	0.44	0.39	141
358	1.00	NSC	16.4	1.4	NSC	0.34	NSC	670
359	5.83	<0.13	27.8	398.0	1.7	0.60	0.75	2,591
361	<0.13	0.23	75.2	2.9	2.9	1.91	IS	170
362	0.49	0.49	15.2	14.1	<0.9	1.32	IS	66
363	<0 13	0.57	21.3	8.2	11.2	0.54	IS	65
364	0.45	0.29	34.0	11.9	4.3	1.22	<0.17	149
365	9.59	4.48	20.2	24.0	27.9	0.37	0.48	4,306
366	1.14	6.23	20.6	3.0	13.7	0.35	0.22	264
367	1.60	0.33	40.7	22.1	4.3	0.50	IS	669
368	<0.13	1.15	13.6	5.7	13.0	0.18	0.32	180
370	0.71	0.75	11.8	18.6	5.9	0.36	IS	114
372	0.26	0.14	14.0	4.0	1.6	0.22	0.47	143
373	2.30	0.42	96.5	9.8	3.3	0.33	0.27	153
374	2.30	1.56	37.0	12.1	20.0	0.68	IS	873
375	0.63	1.23	43.8	14.7	6.0	0.49	0.94	142
378	0.32	0.50	11.4	12.0	11.2	0.54	IS	233
383	0.46	NSC	16.6	8.6	NSC	0.96	NSC	130
384	5.10	NSC	10.5	9.6	NSC	0.24	NSC	2,939
385	0.33	0.39	78.3	4.5	3.5	0.25	IS	191
386	<0.13	0.29	19.6	7.3	15.5	0.65	IS	115
387	0.13	<0.13	38.4	10.5	2.3	0.32	IS	159
388	0.65	1.74	12.9	8.7	14.3	0.26	IS	177
390	1.81	1.15	28.6	11.8	2.7	0.36	0.52	595
391	0.24	1.13	16.4	16.5	12.1	0.29	0.28	6,339
392	0.60	0.29	82.2	3.6	5.9	0.17	IS	237
393	1.57	0.47	27.1	8.8	6.7	<0.17	0.22	185
394	0.47	NSC	14.2	5.5	NSC	0.34	NSC	229
395	3.46	NSC	34.6	13.4	NSC	0.34	NSC	269
396	0.77	NSC	19.2	14.9	NSC	0.36	NSC	72
397	0.87	NSC	33.2	8.3	NSC	0.39	NSC	472
398	0.35	0.31	42.4	18.6	9.8	1.34	0.50	221
399	0.20	<0.13	30.3	<0.9	<0.9	0.81	1.60	199
400	0.26	0.22	19.4	2.4	5.7	0.37	0.30	163
402	0.45	NSC	99.9	5.5	NSC	0.24	NSC	191

(continued)

TABLE A-22 (continued)

Participant I. D.	Cadmium		Copper	Lead		Mercury		Zinc
	Period 1	Period 5	Period 1	Period 1	Period 5	Period 1	Period 5	Period 1
403	0.26	0.18	32.8	1.3	6.9	0.35	IS	130
405	<0.13	1.76	14.8	11.9	8.5	0.62	0.47	142
406	<0.13	0.31	24.0	2.4	<0.9	0.22	IS	187
407	<0.13	0.40	22.5	1.0	3.3	0.18	<0.17	174
408	0.46	0.37	20.5	15.9	17.9	0.35	IS	127
412	0.52	NSC	28.8	9.0	NSC	<0.17	NSC	228
413	0.36	NSC	95.0	21.6	NSC	0.21	NSC	188
414	0.86	0.86	16.7	15.2	18.5	0.67	0.88	92
415	0.22	0.26	56.6	7.1	10.8	0.34	0.48	233
416	0.86	0.47	16.0	16.6	10.4	0.52	0.66	90
417	<0.13	<0.13	24.1	8.4	2.9	0.48	IS	179
418	3.58	3.13	21.3	67.8	50.6	0.28	0.91	653
419	0.26	0.23	48.5	5.4	2.4	0.46	0.30	176
421	0.68	0.84	27.1	13.1	8.5	0.39	0.92	50
422	0.48	2.52	25.7	2.4	17.5	0.81	IS	184
423	<0.13	0.50	25.6	5.4	<0.9	0.46	IS	132
424	1.66	2.91	11.3	27.0	19.1	1.30	IS	65
426	0.40	2.04	31.2	5.2	1.3	1.13	<0.17	129
428	0.36	0.31	28.2	6.5	4.5	0.56	0.17	152
429	0.62	<0.13	13.6	13.3	2.9	0.44	<0.17	132
430	3.16	0.89	13.4	20.6	13.1	0.20	<0.17	99
438	<0.13	NSC	30.2	2.9	NSC	0.90	NSC	153
441	1.26	1.45	24.8	20.3	5.8	2.27	IS	394
442	2.67	IS	18.8	23.8	IS	2.48	IS	187
443	3.14	1.51	14.8	39.2	14.9	1.07	IS	167
445	2.49	1.18	16.0	27.6	6.0	1.33	0.25	266
446	3.77	1.37	17.3	43.9	42.8	1.47	0.38	275
449	2.38	2.51	49.6	19.3	42.2	0.26	IS	215
450	1.47	1.60	80.5	12.6	18.7	0.89	IS	582
451	9.94	1.55	120.0	241.6	18.4	IS	IS	106
452	1.43	NSC	60.6	4.1	NSC	0.54	NSC	289
453	0.39	NSC	23.1	10.7	NSC	0.47	NSC	138
454	0.23	NSC	30.8	9.2	NSC	0.67	NSC	216
455	2.33	1.19	14.6	30.6	12.7	0.47	IS	114
457	1.14	<0.13	33.7	24.4	3.7	0.50	IS	143
458	2.79	0.48	22.9	25.1	10.2	0.37	IS	186
459	1.00	0.50	27.6	11.8	14.3	0.23	<0.17	97
460	0.18	0.54	16.6	1.6	2.4	<0.17	0.33	160
461	0.21	<0.13	21.2	2.2	<0.9	1.19	IS	118
464	0.41	<0.13	14.6	6.4	12.9	0.20	0.48	142
465	3.09	<0.13	33.1	5.8	2.0	0.26	0.21	383
466	0.35	NSC	11.9	20.0	NSC	0.77	NSC	132
467	<0.13	NSC	23.9	5.2	NSC	0.50	NSC	150
500	1.06	0.50	14.9	23.5	19.5	0.83	0.85	104

(continued)

TABLE A-22 (continued)

Participant I.D.	Cadmium		Copper	Lead		Mercury		Zinc
	Period 1	Period 5	Period 1	Period 1	Period 5	Period 1	Period 5	Period 1
501	0.43	NSC	7.9	9.4	NSC	0.41	NSC	56
502	0.74	NSC	105.7	9.9	NSC	0.39	NSC	203
503	1.00	NSC	85.8	8.6	NSC	0.62	NSC	220
504	0.17	0.16	14.9	2.1	3.2	<0.17	IS	143
505	1.15	0.61	30.8	7.9	8.3	1.06	0.45	39
506	0.91	3.01	24.2	20.6	35.8	1.87	0.29	40
507	0.23	0.27	17.9	13.8	9.8	0.80	IS	79
508	1.65	1.30	31.6	18.2	18.4	1.81	1.40	172
509	0.42	0.15	55.1	5.8	3.7	0.76	IS	112
510	3.32	0.47	12.6	29.1	5.9	0.31	<0.17	122
512	NSC	0.68	NSC	NSC	6.0	NSC	0.56	NSC

TABLE A-23 TRACE METAL CONCENTRATIONS IN URINE SAMPLES FROM INDIVIDUAL PARTICIPANTS (μg/l)

Participant I. D.	Cadmium		Copper	Lead		Mercury		Zinc
	Period 1	Period 5	Period 1	Period 1	Period 5	Period 1	Period 5	Period 1
1	1.00	0.32	11.2	10.5	<2.1	8.29	<1.14	365
2	0.81	0.72	12.4	14.0	10.1	9.33	2.88	410
3	0.74	0.44	15.0	40.3	4.5	10.37	1.81	265
4	0.86	1.53	10.1	7.7	4.9	8.29	<1.14	287
5	0.84	0.18	9.9	6.7	<2.1	9.85	<1.14	391
6	0.98	0.24	10.1	14.2	2.4	5.47	2.63	954
9	0.62	0.36	7.1	8.8	9.1	8.81	3.54	205
10	1.05	1.04	18.0	8.6	7.1	16.59	3.37	520
11	0.18	0.90	5.4	3.7	4.4	9.85	1.81	137
12	0.70	0.42	7.4	10.5	4.0	9.85	<1.14	397
13	0.91	0.60	9.7	12.1	5.6	9.85	<1.14	442
14	0.92	0.61	8.4	11.6	9.1	8.81	2.24	128
15	0.24	0.33	3.2	3.5	2.4	7.78	<1.14	301
16	0.72	1.40	9.8	11.7	6.5	7.26	2.89	556
18	0.41	0.22	11.3	10.5	8.2	10.89	4.64	456
19	0.56	0.63	12.4	5.7	5.6	10.37	5.24	237
21	0.18	NSC	9.2	10.3	NSC	10.37	NSC	465
29	1.10	0.79	4.6	6.1	5.1	8.81	5.08	132
30	0.33	0.37	11.7	14.0	4.8	10.37	1.91	328
31	0.59	0.17	11.4	6.8	4.2	7.26	1.67	511
32	1.05	0.42	6.7	23.9	<2.1	7.78	2.21	465
33	0.55	<0.13	15.4	14.9	3.2	8.81	1.47	451
49	0.61	0.02	9.2	9.2	8.8	9.85	1.83	267
50	0.57	0.57	10.3	10.3	5.3	4.77	4.10	1000
70	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
74	0.59	1.15	9.6	9.6	11.3	8.29	1.38	322
75	0.26	0.60	13.7	13.7	3.1	4.15	<1.14	207
76	0.32	0.55	9.2	9.2	5.6	8.24	<1.14	437
77	0.72	0.97	14.5	14.5	5.0	10.89	<1.14	354
78	NSC	0.24	NSC	NSC	4.4	NSC	<1.14	NSC
83	1.19	<0.13	12.6	12.6	<2.1	7.78	<1.14	598
84	0.79	0.51	9.0	9.0	<2.1	8.81	<1.14	529
97	0.85	0.71	11.2	11.2	4.2	8.81	<1.14	203
98	0.15	0.23	8.3	8.3	6.8	8.29	1.30	202
99	1.18	0.25	11.0	11.0	<2.09	7.26	<1.14	460
100	0.39	0.28	2.4	2.4	8.1	1.17	2.66	483
101	0.63	1.14	9.2	9.2	27.7	2.97	<1.14	497
102	0.75	0.22	9.5	9.5	3.0	12.85	5.46	675
103	1.23	0.88	14.9	14.9	10.6	12.85	<1.14	560
113	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
114	0.28	NSC	3.7	3.7	NSC	2.97	NSC	138
115	1.26	NSC	10.4	10.4	NSC	1.89	NSC	364
116	0.47	NSC	16.2	16.2	NSC	1.35	NSC	331
117	0.15	NSC	4.3	4.3	NSC	3.14	NSC	189
131	0.38	0.39	8.1	8.1	3.3	5.02	2.15	331
141	0.44	0.38	15.2	6.5	5.3	8.54	2.24	595
142	0.59	0.83	17.2	9.8	<2.1	19.07	1.89	489

(continued)

TABLE A-23 (continued)

Participant I. D.	Cadmium		Copper	Lead		Mercury		Zinc
	Period 1	Period 5	Period 1	Period 1	Period 5	Period 1	Period 5	Period 1
143	0.39	0.50	8.6	10.5	2.4	3.09	<1.14	427
144	0.28	0.58	16.8	6.8	4.6	2.39	1.91	812
145	0.35	0.14	2.9	3.5	<2.1	2.07	1.72	450
146	0.61	0.91	7.8	2.5	3.1	8.32	1.30	115
157	0.73	2.06	8.9	20.8	13.3	<1.14	1.89	473
158	0.62	0.27	18.0	9.5	3.7	2.67	<1.14	950
159	0.20	0.73	7.0	4.8	<2.1	1.55	<1.14	312
160	0.89	0.51	43.8	6.8	4.9	3.09	<1.14	7406
162	0.60	0.50	11.5	4.0	3.4	<1.14	2.32	441
165	0.98	0.50	13.0	4.0	6.1	6.36	7.20	473
166	0.33	1.10	13.8	12.9	6.1	2.93	1.91	363
167	0.30	NSC	10.8	<2.1	NSC	4.64	NSC	393
171	0.48	1.16	7.1	8.7	3.5	<1.14	<1.14	560
172	0.45	0.23	5.5	7.7	9.2	2.93	2.68	386
177	1.46	1.15	7.1	5.9	3.6	<1.14	1.26	175
178	0.83	0.78	2.7	<2.1	4.2	<1.14	<1.14	142
179	0.71	0.37	10.4	14.1	<2.1	2.39	1.21	312
180	0.36	0.34	15.4	11.8	8.4	1.96	3.13	268
181	2.48	1.63	20.8	22.6	15.6	2.39	1.24	672
182	1.38	0.63	16.8	12.5	6.8	10.27	6.41	622
183	0.50	0.66	6.4	5.0	11.5	9.78	1.64	346
189	0.61	NSC	14.1	18.7	NSC	4.35	NSC	986
190	0.14	NSC	5.2	3.6	NSC	5.38	NSC	134
191	0.21	NSC	5.4	4.8	NSC	5.87	NSC	489
192	0.15	NSC	10.5	8.7	NSC	3.09	NSC	521
193	0.18	NSC	10.8	8.7	NSC	6.85	NSC	504
194	0.57	NSC	18.0	13.1	NSC	<1.14	NSC	844
195	0.57	NSC	17.0	8.7	NSC	2.39	NSC	986
196	0.48	1.03	8.7	7.1	7.3	8.32	6.41	346
198	0.44	0.42	12.7	10.1	9.5	10.27	1.67	480
199	0.27	0.82	7.9	2.3	4.0	9.78	1.59	286
201	0.28	NSC	15.9	2.6	NSC	8.32	NSC	253
202	< 0.13	NSC	15.2	11.0	NSC	9.29	NSC	515
206	0.48	0.47	13.8	7.5	<2.1	10.89	<1.14	281
207	0.51	0.72	14.9	17.7	17.5	10.37	2.64	557
208	0.19	0.38	12.5	11.9	<2.1	3.37	<1.14	871
209	0.63	1.31	11.6	17.0	10.2	3.08	<1.14	543
213	0.73	0.76	10.5	11.0	5.5	12.44	<1.14	379
214	0.72	0.96	5.5	12.5	4.6	6.85	<1.14	271
226	0.42	1.45	13.9	11.0	12.1	12.23	8.54	290
227	1.07	1.39	11.7	23.3	18.8	7.83	1.59	489
228	0.90	0.97	12.1	15.2	7.5	5.41	4.02	337
229	0.39	0.80	11.5	10.1	12.9	4.44	2.32	529
230	0.49	1.42	14.2	6.6	9.9	2.12	2.15	454
231	0.28	0.20	11.1	8.3	<2.1	2.50	2.58	337
232	< 0.13	1.21	17.2	8.4	4.2	<1.14	1.59	206
233	0.62	0.23	6.1	2.5	2.5	3.67	1.83	84

(continued)

TABLE A-23 (continued)

Participant I. D.	Cadmium		Copper	Lead		Mercury		Zinc
	Period 1	Period 5	Period 1	Period 1	Period 5	Period 1	Period 5	Period 1
235	1.17	0.31	16.5	16.7	3.0	2.89	<1.14	477
239	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
241	0.46	0.48	16.4	10.6	3.9	3.86	<1.14	285
242	0.33	1.37	13.8	14.1	3.1	12.72	3.47	529
243	2.51	0.80	7.4	4.2	3.8	4.63	<1.14	134
244	0.33	0.98	29.7	16.3	7.3	4.82	<1.14	471
254	0.33	NSC	10.2	11.9	NSC	6.56	NSC	424
255	< 0.13	NSC	4.3	19.7	NSC	2.12	NSC	375
256	0.37	NSC	11.4	9.4	NSC	2.70	NSC	564
257	0.35	NSC	4.5	8.4	NSC	1.93	NSC	328
258	1.00	NSC	5.0	6.0	NSC	3.09	NSC	92
260	0.36	0.91	12.1	10.6	7.6	3.09	<1.14	880
262	1.11	1.15	16.2	30.8	12.1	13.74	2.81	844
263	0.52	0.55	6.7	9.4	11.9	2.51	1.24	342
266	0.35	1.37	6.4	6.0	8.0	<1.14	1.55	308
267	0.82	0.17	11.7	15.2	5.6	21.99	1.75	755
268	0.77	< 0.13	18.9	10.1	5.3	10.74	<1.14	1412
273	1.88	0.98	19.5	17.4	9.6	2.67	<1.14	1291
275	0.28	< 0.13	5.5	7.5	<2.1	1.54	<1.14	360
276	0.45	0.22	5.5	7.5	2.4	1.68	<1.14	456
278	0.78	1.00	11.9	6.6	7.2	5.38	<1.14	447
284	0.42	1.29	2.8	7.5	10.9	1.54	1.79	190
290	0.38	0.39	8.4	13.3	3.1	4.24	2.07	377
293	1.40	NSC	14.6	28.2	NSC	7.72	NSC	638
294	1.38	1.85	11.4	4.8	6.5	3.28	<1.14	295
295	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
302	0.40	0.30	5.1	4.3	7.8	3.28	2.15	524
303	1.26	1.24	4.5	8.5	8.4	2.70	1.26	181
312	0.63	0.55	7.1	22.4	8.4	3.28	2.00	421
313	0.81	0.28	12.9	10.4	2.9	3.09	3.05	746
314	4.12	0.86	19.1	6.7	5.0	2.51	<1.14	481
315	0.64	0.44	16.8	14.9	8.5	<1.14	1.30	614
316	0.58	0.94	7.5	2.4	3.5	1.93	<1.14	143
324	1.67	1.15	9.5	9.2	8.0	3.90	<1.14	557
325	0.24	0.88	5.7	4.2	4.6	4.44	2.15	562
330	0.98	0.98	8.2	4.8	13.3	2.70	2.40	114
334	NSC	0.44	NSC	NSC	10.7	NSC	1.21	NSC
335	0.87	0.18	16.9	7.6	14.1	6.45	<1.14	1351
336	0.57	0.35	15.4	9.2	8.0	3.67	1.30	561
337	0.19	0.22	10.1	10.1	8.0	2.70	1.24	538
338	0.36	< 0.13	14.1	14.1	3.4	7.91	1.55	561
339	0.71	0.95	6.7	6.7	2.1	2.83	<1.14	357
340	0.71	0.97	7.8	7.8	8.0	3.09	<1.14	482
341	0.41	1.22	18.5	18.5	7.1	2.70	1.81	491
342	0.69	0.49	8.4	8.4	<2.1	2.51	1.55	419
343	0.60	0.38	7.8	7.8	4.3	5.31	<1.14	357
344	1.26	NSC	15.4	15.4	NSC	2.39	NSC	982

(continued)

TABLE A-23 (continued)

Participant I. D.	Cadmium		Copper	Lead		Mercury		Zinc
	Period 1	Period 5	Period 1	Period 1	Period 5	Period 1	Period 5	Period 1
348	1.20	1.41	21.7	21.7	4.5	4.05	1.89	798
349	0.82	0.77	19.6	19.6	10.1	8.68	6.62	620
350	0.35	0.67	14.6	14.6	5.3	3.09	2.21	509
353	0.72	0.15	5.1	5.1	<2.1	2.51	1.65	536
354	0.90	< 0.13	10.2	10.2	<2.1	3.67	1.34	285
355	0.25	0.33	9.7	9.7	5.4	5.89	2.31	912
356	5.05	0.23	24.4	24.4	8.0	5.4	1.89	719
359	1.72	0.66	12.2	12.2	3.3	1.54	<1.14	256
361	0.70	0.49	13.6	13.6	9.0	3.09	2.78	329
362	0.59	< 0.13	15.7	15.7	2.4	1.42	<1.14	439
363	0.89	0.20	13.6	13.6	3.9	2.70	<1.14	536
364	2.43	0.17	13.8	13.8	<2.1	4.24	<1.14	667
365	0.26	0.15	7.8	7.8	2.6	6.56	<1.14	430
366	1.05	1.32	12.3	12.3	8.4	7.79	1.38	541
367	0.69	0.77	7.8	7.8	7.6	6.17	1.91	570
368	0.48	0.47	12.9	12.9	6.0	5.40	<1.14	441
370	0.83	1.02	8.1	8.1	5.2	10.61	1.65	329
372	0.76	0.86	13.2	13.2	14.3	1.42	1.21	461
373	0.50	< 0.13	5.5	5.5	3.3	8.15	<1.14	560
374	0.80	1.03	11.5	11.5	5.1	7.72	1.37	538
375	0.60	< 0.13	7.0	7.0	3.9	10.27	1.55	306
378	2.42	1.07	8.9	8.9	6.7	1.54	<1.14	264
383	1.07	NSC	8.9	8.9	NSC	1.35	NSC	774
384	1.62	NSC	14.6	14.6	NSC	2.89	NSC	817
385	0.61	0.38	14.5	14.5	13.7	2.70	2.58	589
386	0.50	0.34	7.0	7.0	7.9	2.27	2.63	403
387	0.47	1.52	7.5	7.5	3.5	<1.14	<1.14	422
388	0.97	0.82	11.5	11.5	7.6	<1.14	<1.14	435
390	0.85	0.19	15.2	15.2	6.0	2.83	3.26	468
391	0.97	0.76	13.1	13.1	22.1	3.47	<1.14	454
392	0.31	0.78	9.4	9.4	2.8	2.51	1.47	556
393	0.64	0.88	14.2	14.2	5.0	2.81	<1.14	380
394	0.60	NSC	15.2	15.2	NSC	1.26	NSC	422
395	0.52	NSC	<2.02	<2.02	NSC	1.54	NSC	460
396	0.58	NSC	20.9	20.9	NSC	1.54	NSC	669
397	0.80	NSC	10.6	10.6	NSC	6.87	NSC	491
398	0.18	0.74	5.1	6.8	6.8	<1.14	4.20	269
399	0.90	0.83	14.7	15.6	5.5	6.02	4.22	482
400	0.22	0.57	4.9	6.2	8.1	16.24	5.25	314
402	1.13	NSC	14.9	20.1	NSC	8.15	NSC	694
403	2.28	0.74	10.6	15.6	11.6	<1.14	3.89	420
405	0.22	0.26	7.2	11.2	4.2	6.73	2.75	565
406	0.56	0.30	12.5	10.5	<2.1	11.08	3.19	455
407	4.51	0.85	18.9	10.9	4.6	2.48	1.91	678
408	1.83	0.37	19.3	27.9	3.7	9.21	3.26	950
412	0.76	NSC	8.2	5.5	NSC	2.27	NSC	212
413	0.56	NSC	6.6	10.5	NSC	<1.14	NSC	159

(continued)

TABLE A-23 (continued)

Participant I. D.	Cadmium		Copper	Lead		Mercury		Zinc
	Period 1	Period 5	Period 1	Period 1	Period 5	Period 1	Period 5	Period 1
414	1.07	0.49	9.9	7.6	10.9	<1.14	1.24	385
415	1.43	0.16	13.1	18.9	<2.1	3.91	2.32	609
416	0.43	0.66	10.3	7.9	18.6	6.81	<1.14	367
417	0.66	0.77	4.9	6.6	2.6	4.16	<1.14	323
418	0.31	0.84	7.2	6.9	10.7	1.77	4.19	491
419	1.22	0.85	13.1	21.3	9.9	4.96	2.15	748
421	0.81	0.77	6.7	6.6	6.6	2.83	6.30	504
422	1.99	0.62	9.7	14.6	6.9	4.96	1.34	420
423	0.69	1.91	12.8	9.1	8.6	10.98	1.34	354
424	1.17	0.20	18.3	8.1	5.3	7.08	3.26	287
426	2.60	0.70	32.6	9.9	8.9	2.13	1.34	326
428	0.38	0.43	15.1	4.0	7.3	1.77	2.68	304
429	1.11	0.60	16.8	15.9	5.6	11.34	2.92	843
430	0.95	0.14	12.2	14.6	8.5	1.14	<1.14	362
438	1.44	NSC	12.2	25.1	NSC	3.19	NSC	661
441	1.05	0.38	12.2	9.0	5.0	10.98	3.54	379
442	0.45	0.18	14.8	5.5	4.1	2.83	<1.14	542
443	0.63	0.19	11.3	15.2	2.4	6.73	5.64	428
445	0.37	0.28	12.5	8.0	2.3	3.54	<1.14	626
446	NSC	0.79	NSC	NSC	11.4	NSC	<1.14	NSC
449	0.59	0.81	5.1	5.5	14.3	<1.14	1.34	380
450	1.17	0.47	7.8	10.3	5.3	1.51	<1.14	313
451	NSC	NSC	NSC	NSC	NSC	NSC	NSC	NSC
452	0.18	NSC	3.5	4.2	NSC	1.51	NSC	265
453	1.06	NSC	14.2	14.0	NSC	6.35	NSC	620
454	0.77	NSC	8.5	9.1	NSC	3.19	NSC	454
455	1.00	0.87	11.0	17.7	6.1	5.67	<1.14	608
457	0.95	0.76	5.3	10.3	2.3	<1.14	2.31	494
458	0.47	0.14	10.8	6.2	5.3	7.09	<1.14	300
459	1.08	0.22	13.1	10.9	<2.1	7.44	3.37	1052
460	0.47	0.14	13.8	9.9	2.7	10.91	2.37	464
461	1.35	0.21	12.8	4.7	<2.1	1.40	<1.14	494
464	1.17	0.96	12.5	15.6	8.0	5.19	2.56	782
465	0.72	0.17	6.7	17.7	4.6	3.51	1.91	852
466	0.30	NSC	6.5	6.1	NSC	<1.14	NSC	581
467	0.88	NSC	6.3	6.6	NSC	6.02	NSC	437
500	NSC	1.82	NSC	NSC	6.5	NSC	<1.14	NSC
501	0.56	NSC	7.9	<2.1	NSC	3.19	NSC	494
502	0.56	NSC	11.2	6.9	NSC	7.09	NSC	616
503	0.18	NSC	6.9	5.5	NSC	11.69	NSC	372
504	0.87	0.84	9.9	18.9	<2.1	<1.14	<1.14	411
505	0.17	0.21	10.8	8.3	4.2	<1.14	<1.14	468
506	0.51	0.47	15.4	14.1	8.9	2.10	1.85	433
507	0.90	<0.13	12.9	8.5	2.4	1.26	1.85	280
508	NSC	0.36	NSC	NSC	6.0	NSC	2.07	NSC
509	0.39	NSC	4.9	10.3	NSC	1.96	NSC	170
510	0.73	0.55	7.1	14.0	4.8	2.10	<1.14	748
512	NSC	0.28	NSC	NSC	6.9	NSC	<1.14	NSC

TABLE A-24 HEMATOCRIT VALUE OF BLOOD SAMPLES FROM INDIVIDUAL PARTICIPANTS

Participant I. D.	Hematocrits		
	Period 1	Period 2	Period 5
1	43	42	43
2	38	NSC	36
3	42	NSC	44
4	47	47	45
5	42	42	43
6	43	42	46
9	40	42	NSC
10	40	42	42
11	38	39	NSC
12	46	41	45
13	43	46	46
14	44	44	44
15	39	43	42
16	40	40	42
18	40	39	NSC
19	43	43	38
21	NSC	NSC	NSC
29	42	42	NSC
30	41	38	41
31	41	38	43
32	42	40	NSC
33	38	37	NSC
49	37	41	41
50	41	48	52
74	45	46	44
75	40	42	43
76	38	NSC	39
77	37	NSC	NSC
78	NSC	NSC	NSC
83	40	43	44
84	41	47	42
97	48	48	52
98	NSC	40	38
99	NSC	NSC	NSC
100	39	40	42
101	44	42	49
102	45	41	40
103	39	43	43
113	38	38	NSC
114	39	40	NSC
115	42	46	NSC
116	39	41	NSC
117	38	39	NSC
131	40	38	NSC
141	40	41	39
142	40	39	41
143	39	39	39
144	36	41	42
145	45	47	48
146	43	44	44
157	48	47	48
158	47	42	44
159	NSC	NSC	39
160	NSC	NSC	38
162	42	43	40
165	45	45	45
166	38	37	35
167	41	NSC	NSC
171	NSC	37	38
172	NSC	38	41

(continued)

TABLE A-24 (continued)

Participant I. D.	Hematocrits		
	Period 1	Period 2	Period 5
177	41	47	47
178	39	43	43
179	34	42	44
180	34	42	41
181	32	48	45
182	39	39	39
183	NSC	35	35
189	46	47	NSC
190	43	43	NSC
191	37	36	NSC
192	38	39	NSC
193	NSC	38	NSC
194	38	38	NSC
195	NSC	NSC	NSC
196	44	43	43
198	38	39	NSC
199	39	38	41
201	43	41	NSC
202	NSC	41	NSC
206	43	43	48
207	37	36	37
208	43	44	43
209	39	38	38
213	45	45	44
214	40	41	40
226	39	39	37
227	46	47	44
228	38	43	42
229	40	42	42
230	37	NSC	NSC
231	41	38	35
232	NSC	NSC	38
233	45	43	44
235	NSC	NSC	38
241	42	39	43
242	43	44	46
243	39	38	39
244	40	37	41
254	41	NSC	NSC
255	NSC	42	NSC
256	39	38	NSC
257	41	39	NSC
258	52	47	NSC
260	47	44	44
262	35	39	41
263	40	37	40
266	44	47	47
267	39	39	41
268	41	47	46
273	42	42	48
275	43	40	38
276	36	37	37
278	36	37	38
284	42	48	NSC
290	35	42	39
293	38	41	NSC
294	47	44	NSC
295	45	NSC	NSC
302	46	49	52
303	40	44	41
312	44	44	47

(continued)

TABLE A-24 (continued)

Participant I. D.	Hematocrits		
	Period 1	Period 2	Period 5
313	NSC	38	42
314	38	42	NSC
315	NSC	38	39
316	42	40	40
324	42	43	42
325	38	42	42
330	47	49	48
334	34	47	48
335	34	41	40
336	38	43	43
337	38	41	41
338	39	NSC	40
339	39	41	40
340	NSC	NSC	37
341	NSC	38	39
342	NSC	42	NSC
343	50	47	49
348	37	NSC	36
349	NSC	46	NSC
350	41	41	NSC
353	41	39	41
354	38	38	39
355	38	38	41
356	36	37	40
359	40	43	42
361	38	38	37
362	38	40	37
363	NSC	NSC	36
364	48	48	48
365	37	36	36
366	39	38	38
367	42	40	42
368	34	40	43
370	38	38	40
372	43	43	38
373	NSC	NSC	38
374	41	46	46
375	NSC	NSC	38
378	49	NSC	47
383	38	NSC	NSC
384	45	NSC	NSC
385	35	36	40
386	39	40	41
387	37	39	38
388	38	38	36
390	37	37	37
391	39	NSC	35
392	36	35	39
393	42	42	NSC
394	41	43	NSC
395	37	38	NSC
396	36	NSC	NSC
397	43	44	NSC
398	41	38	39
399	44	44	42
400	45	43	44
402	44	45	NSC
403	41	42	38
405	48	45	46
406	43	40	38

(continued)

TABLE A-24 (continued)

Participant I. D.	Hematocrits		
	Period 1	Period 2	Period 3
407	35	41	38
408	43	45	43
412	45	37	NSC
413	40	38	NSC
414	NSC	NSC	41
415	41	44	43
416	38	37	41
417	44	43	42
418	49	51	46
419	45	45	43
421	39	38	NSC
422	44	44	43
423	NSC	47	44
424	39	38	38
426	40	42	39
428	38	41	NSC
429	47	43	NSC
430	NSC	NSC	NSC
438	45	45	NSC
441	45	43	42
442	38	38	39
443	34	36	35
445	39	41	39
446	36	35	35
449	44	45	49
450	35	NSC	36
451	NSC	NSC	NSC
452	42	40	NSC
453	45	43	NSC
454	43	43	NSC
455	43	42	43
457	38	39	39
458	36	38	38
459	38	42	41
460	39	47	43
461	44	42	42
464	44	48	49
465	33	41	43
466	46	45	NSC
467	41	39	NSC
500	32	NSC	34
501	43	NSC	NSC
502	36	42	NSC
503	38	43	NSC
504	33	39	41
505	NSC	NSC	40
506	36	35	34
507	32	38	38
508	44	46	48
509	36	45	42
510	43	45	45
511	NSC	NSC	NSC
512	NSC	41	41